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# Evaluating Virtual Human Role-Players to Practice & Develop Leadership Skills

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*Author:*

Gonzalo Suarez

*Senior Supervisor:*

Prof. Robert W. Lindeman

*Co-Supervisor:*

Dr. Sungchul Jung

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# *Abstract*

Many organizations are dissatisfied with the outcomes of their leadership training efforts despite the significant money they are investing in training programs. Researchers suggest that practice-based training techniques, such as role-playing, are the most critical and effective for influencing training outcomes. However, role-playing suffers from several drawbacks, including cost, both in terms of time and money. In response, the rapid development in human-computer interaction may offer an opportunity to complement and support traditional training delivery methods with a more scalable and cost-effective approach. This thesis evaluates the effectiveness of virtual human (VH) role-players within two computer-generated environments: virtual reality (VR), and mixed reality (MR).

An experimental platform was developed to provide an interactive training experience with either real or virtual humans during structured role-play scenarios driven by turn-based branching narratives. The narratives were designed following the framework of a proven, time-tested leadership model, and a user study experiment was conducted. We investigated (1) if VH role-players were as effective as real human (RH) role-players to support the practice of leadership skills, and (2) the impact that both computer-generated environments had on the outcomes. Finally, we collected user reactions and learning feedback from the overall training experience.

Results showed that VHS can be effective training tools to support the practice of leadership skills. Both computer-generated environments had positive impacts on the training experience. However, the MR environment had a greater influence on the overall results in comparison to the VR environment. The analysis and evaluation of the results showed that the overall training was a consistent and positive experience.

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# Abbreviations

<b>GPU</b>	<b>G</b> raphic <b>P</b> rocessing <b>U</b> nit
<b>HMD</b>	<b>H</b> ead- <b>M</b> ounted <b>D</b> isplay
<b>SLII®</b>	<b>S</b> ituational <b>L</b> eadership® <b>II</b>
<b>MR</b>	<b>M</b> ixed <b>R</b> eality
<b>VH</b>	<b>V</b> irtual <b>H</b> uman
<b>VR</b>	<b>V</b> irtual <b>R</b> eality

# Chapter 1

## Introduction

This chapter provides the background and motivation of our study. Section one discusses the importance of leadership and identifies the general dissatisfaction that companies have in regards to the outcomes of their leadership development efforts. Section two discusses the current disadvantages of leadership training programs. Finally, section three identifies current limitations in traditional training methods and proposes an alternative solution by evaluating a cost-effective technology.

### 1.1 The Importance of Leadership Development

Corporate training allows organizations to adapt, innovate, produce, and reach goals [6]. In 2013, organizations worldwide spent over \$130 billion on training programs [7]. Similarly, in 2015, training continued to be a priority based on the results collected from 310 organizations representing a diverse range of industries [8]. Finally, in 2019, more than 1,200 learning and development professionals and over 2,100 workplace learners worldwide were surveyed to investigate the latest industry trends. The results indicate that training budgets, in comparison with previous years, do not represent a top challenge within organizations [9].

According to training reports, the majority of the budgets tend to be allocated to the development of social skills, also known as interpersonal skills [7, 8]. Rungapadiachy [10, p. 193] defines social skills as “those skills which one needs in order to communicate effectively with another person or a group of people”. In management training programs,

social skills are generally composed of leadership, negotiation, and communication skills. Although all three represent significant areas of development, leadership represents the most significant expense item in the total training and development budget of the majority of the organizations in the United States and many other countries worldwide [11, 12].

The quality of management and leadership practices can significantly improve worker productivity and profitability across organizations and countries [13]. Leaders influence organizational effectiveness by motivating and inspiring their human capital. As defined by Yukl [14, p. 2], leadership is “the process of influencing others to understand and agree about what needs to be done and how to do it, and the process of facilitating individual and collective efforts to accomplish shared objectives”. Furthermore, leaders represent an essential pillar for the growth of healthy work cultures. As declared by Schein [15, p. 3], “culture is ultimately created, embedded, evolved, and ultimately manipulated by leaders”.

Companies have long recognized the need for leadership development at all levels and across all work areas. However, only a small minority of organizations consider their leadership training programs can generate a real impact. Numerous articles and reports indicate that many businesses are unsatisfied with the results of their leadership development efforts [1, 16]. In 2013, a survey that included 2,532 businesses in 94 countries provided critical findings of the priorities and preparation of managers and human resources professionals. The results indicated that leadership is by far the most critical talent acquisition [17]. According to Schwartz et al. [17], “not only are companies not developing enough leaders, but they are also not equipping the leaders they are building with the critical capabilities and skills they need to succeed”.

As noted by Kaiser & Curphy [1], organizations have recognized that there is a leadership crisis, and each year companies invest significant money to address it. However, despite increased spending over more than a decade, the problem seems to get even worse (Fig. 1.1). These figures call into question the effectiveness of leadership development programs.

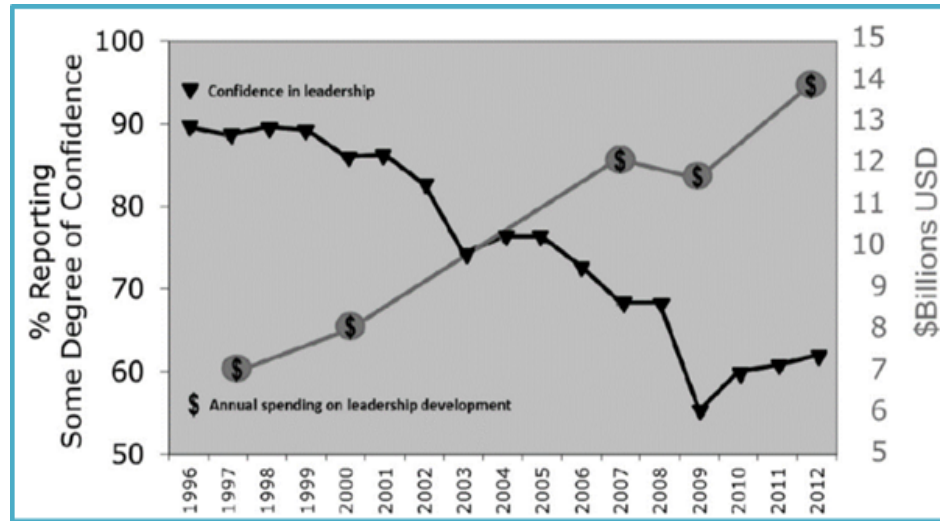


FIGURE 1.1: Annual investment in leadership training and amount of confidence in leadership in the United States [1, p. 295]

## 1.2 Disadvantages of Leadership Training Programs

Leadership training programs have been methodically designed to enhance leader knowledge, skills and abilities [18]. However, it is also declared that most leadership training and development programs are event-based instructions designed for ease of operational delivery within organizations. Thus, leadership training is generally imparted in one or two-day sessions, where the inherent belief is that trainees are prepared to learn the skills through a fast pace and produce little understanding [19].

Because of time constraints, cramming all the critical components into one prolonged training session makes sense from a logistic point of view, but this approach also may restrict learning retention. According to learning efficiency theories like Cognitive load theory (CLT), learners have a restricted working memory capacity, and they can often be overwhelmed by an unnecessary amount of information on instructions and tasks [20]. Congruently, if an unreasonable amount of information is given to a trainee, even though the information is recorded into working memory, it may not be processed into long-term memory, and the trainee's ability to retrieve the information in the future is inhibited [21]. Another limitation is that training programs are expensive, and the budgets tend to be consumed by design and delivery, leaving little for evaluation [1]. Schwartz et al. [19], Levy et al. [17], and Sogunro [22], have identified the deficiency of training programs to support and encourage trainees to put into practice what they have learned.

As recognized by Sogurno [22], leadership skills are not so easily acquired using only theory, talk, and discussion groups.

Rapid advances in human-computer interaction may offer a viable solution to address the current limitations of leadership training initiatives [23]. Researchers have noted that when leaders have the opportunity to practice leadership competencies, they can reflect on their own experience, resolve problems, and engage in the learning process, thus enhancing the extent to which they learn [24]. This investigation aims to address the general dissatisfaction that organizations have concerning their leadership development efforts by evaluating the effectiveness of virtual humans as tools intended to support the practice of leadership skills. The following section provides an overview of the conventional delivery methods used to structure training programs and how the use of technology can offer support to address the current limitations.

### 1.3 Supporting Training Methods with Technology

In general, training delivery methods can be broadly categorized based on their purpose: (a) to provide information (i.e., information-based); (b) to demonstrate targeted competencies (i.e., demonstration-based); or (c) to provide opportunities for practice and feedback (i.e., practice-based) [25]. Information-based methods include lectures, presentations, and text-based training materials. Demonstration-based methods include examples of the skills and abilities trained via in-person, audio, or videos. Finally, practice-based methods include role-playing dynamics, practice, and simulations [26].

Based on the previous categorization, studies consider that the most effective training programs generally include aspects of all three delivery methods [27]. However, generic training literature [25] also suggests that practice-based training techniques are considered to be the most vital when influencing training outcomes. According to Weaber et al. [25, p. 209], “practical learning experiences shape learner perceptions of professional norms, values, and mental models of desirable behavior to a much stronger extent than any classroom experience”. Moreover, constructivist learning theory [28] supports practice-based methods, suggesting that learning improves when the learner develops constructions of the world through direct experience, and when he or she can reflect on these experiences.



Under the category of practice-based methods, role-playing has been declared as a powerful training technique used to develop social skills, including leadership, conflict management, negotiation, and communication [29, 30]. As declared by Ments [29, p. 24], “no matter how much reading and observing the student undertakes, the only way to develop interpersonal and communication skills fully is by using them in actual interpersonal situations”. Sogunro [22, p. 356] defines role-playing as “a learning activity in which participants act out a set of defined role behaviors or position with a view to acquiring desired experiences”. During role-playing sessions, participants experience pre-defined social situations (e.g., practice communication skills while presenting in front of co-participants), and they also receive performance feedback (e.g., co-participant or facilitator feedback) [31]. Role-playing provides a link between talk and action, allowing the participants the chance to associate knowledge and practice with real situations [32]. According to Sogunro [22], role-play dynamics influence how rapidly information and skills are acquired, and also provide role-players with the opportunity to develop and improve in learning in a practical setting.

The effectiveness of role-playing has been shown in diverse training settings, facilitating trainees with the retention of information through direct practice [22]. However, role-playing has also been criticized. First, its implementation can be expensive, both in terms of time and money. As a result, the number of role-playing activities that are organized is low. Second, the development of the activities can require specialist knowledge or the involvement of other agents such as professional actors. Third, trainees generally need more than one session to be able to build a strong learning foundation [23, 29]. Lastly, as recognized by Sogunro [22], role-playing can also be threatening to the role-players who do not feel comfortable talking in the presence of other people, which may negatively impact the overall learning experience.

The previous drawbacks in role-playing are within the scope of this investigation, and represent opportunities for improvement that the technology may be able to address. Role-playing is still an effective training technique used to practice and develop leadership skills. However, this study proposes an alternative outlook by evaluating the effectiveness of virtual human (VH) role-players, as leadership training tools, within two computer-generated environments: virtual reality (VR), and mixed reality (MR). The impact of both technologies is also within the scope of this investigation. Finally, to determine the effectiveness, this study proposes to compare VHs role-players to real human

(RH) role-players during eight structured scenarios built with content of a time-tested leadership model, the Situational Leadership<sup>®</sup> II (SLII<sup>®</sup>)<sup>1</sup> model, developed by The Ken Blanchard Companies<sup>®</sup>.

The effectiveness of VHs, and the impact of both computer-generated environments, were evaluated by an analysis of the *learning performance, stress levels, and social presence indicators*. We compared three conditions. Real human role-players (RH), VH role-players in VR (VH-VR), and VH role-players in MR (VH-MR). Learning performance was determined based on the SLII<sup>®</sup> framework, measured by the scores obtained during the scenarios. The stress levels were measured using both a heart-rate monitor and the Dundee Stress State Questionnaire (DSSQ), used extensively by the scientific community. Social presence was evaluated using the Social Presence scale by Bailenson et al. [33]. Finally, an analysis of Kirkpatrick's<sup>2</sup> level one and level two was conducted to assess the overall training experience. The Kirkpatrick model is considered as a well-known model for analyzing and evaluating the results of formal and informal training. Level one is known as Reaction (e.g., how participants feel about the training), and level two is known as Learning (e.g., increases in knowledge, skills, or experience) [34].

## 1.4 Research Questions

This study aims to answer the following research questions:

- Is the use of virtual human role-players an effective training tool for practicing and developing leadership skills?
- Which computer-generated environment (VR or MR) has a greater impact on learning performance, stress levels, and social presence indicators?

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<sup>1</sup>SLII: <https://www.kenblanchard.com/Products-Services/Situational-Leadership-II/>

<sup>2</sup>Kirkpatrick Model: <https://www.kirkpatrickpartners.com/>

### 1.4.1 Hypotheses

We had three hypotheses for the experiment which were as follows:

- H1: There is no significant difference in learning performance scores among the three conditions (RH, VH-VR, VH-MR).
- H2: Learning performance scores will be significantly higher in the post-test level, in comparison to the pre-test level for all three conditions.
- H3: There is a significant difference in stress levels among the RH condition, and the other two conditions with VHs.

### 1.4.2 Contribution

As declared by Wexley & Latham [35], leadership skills are learned during interaction with other people. Therefore, an effective leadership training solution should provide regular practice while interacting with others. We have investigated that role-playing is an effective practice-based method used to practice and develop leadership skills. However, we have also recognized some of its limitations. The purpose of the evaluation is to understand whether VH role-players can address some of those limitations. To determine the effectiveness, VH role-players are compared to a gold standard: RH role-players. As part of this investigation, we are also interested in understanding the impact of both computer-generated environments (VR and MR) used to render the experience with VHs.

The main contributions of this thesis are:

- The evaluation of a cost-effective technology intended to tackle the current disadvantages and limitations faced by leadership training programs and traditional training delivery methods.
- The evaluation of the impact that two computer-generated environments (VR and MR) have on the outcomes of this investigation.

## 1.5 Thesis structure

This thesis is structured as follows:

**Chapter 2:** Discusses the related work done with VH role-players, describes virtual environments, and provides an overview of the SLII® model.

**Chapter 3:** Explains the design and implementation of the prototype.

**Chapter 4:** Describes the user experiment and discusses each step of the evaluation process.

**Chapter 5:** Presents the results obtained from the user study.

**Chapter 6:** Discusses the results found and describes the limitations of the study.

**Chapter 7:** Identifies possible future areas of research and concludes the thesis.

## Chapter 2

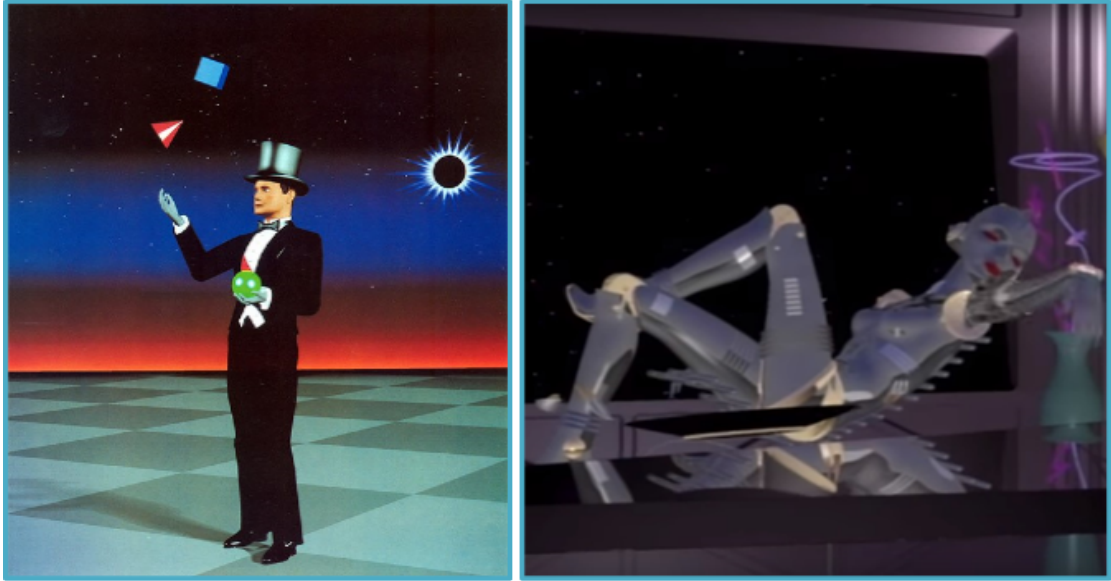
# Related Work

This chapter reviews the related work done on the topic. Section one discusses the concept of VHS, and provides a brief description of virtual environments. Section two describes current investigations where VHS have successfully been used as training tools. Finally, the last section provides an overview of the SLII<sup>®</sup> model used to structure the role-play scenarios.

### 2.1 Virtual Humans & Virtual Environments

During the early 1980s, short movies were displaying high-quality animations involving realistic VHS (Fig. 2.1) [36]. Since then, human-computer interaction has increasingly evolved in computation speed and control methods, allowing rendering three-dimensional (3D) VHS much faster, with realistic graphics, and also suitable for real interactive applications [23, 37, 38].

VHS are conceived as interactive digital representations of humans who coexist in virtual environments where they can move around and interact with participants using human attributes like facial expressions, posture, and voice [3, 39]. According to Fox et al. [40], VHS can be categorized as Agents or as Avatars. On the one hand, agents are fully programmed and controlled by computer algorithms. Guetterman et al. [41, p. 506] define them as “intelligent computer-generated conversational agents with human form and the ability to interact with humans using verbal and nonverbal behaviors very similar to those people use in face-to-face interactions with each other”. On the other



The Juggler from Adam Powers

Sexy Robot from Robert Abel

FIGURE 2.1: High-quality VH animations from the early 1980s

hand, avatars are controlled and animated by real humans. Waltemate et al. [38, p. 1643] consider that avatars represent a “direct extension of ourselves into the virtual domain”. However, as suggested by Schmid et al. [3], the difference between agents and avatars is not always cut clear, as in many systems, agents need to be controlled and triggered by a real human via computer.

The virtual environment, where VHs are deployed, represents a multi-dimensional experience that can be totally or partially computer generated [23]. As introduced by Milgram and Kishino [2], there is a continuum of possible combinations between the real and virtual environment (Fig. 2.2). These combinations ranged from overlaying virtual objects into the real world, Augmented Reality (AR), to capturing real objects superimposing them into the virtual environment, Augmented Virtuality (AV). Mixed Reality (MR) combines real and virtual worlds throughout the reality-virtuality continuum encompassing both AR and AV.

Typically, both virtual environments and VHs are presented to the participants in a two-dimensional (2D) screen-based platform (e.g., desktop), where participants sit in front of a monitor and use a mouse to interact [3]. Recently, web, Virtual Reality (VR), Mixed Reality (MR), and Augmented Reality (AR) are becoming popular platforms as technology improves [42]. Milgram et al. consider that in a VR environment participants

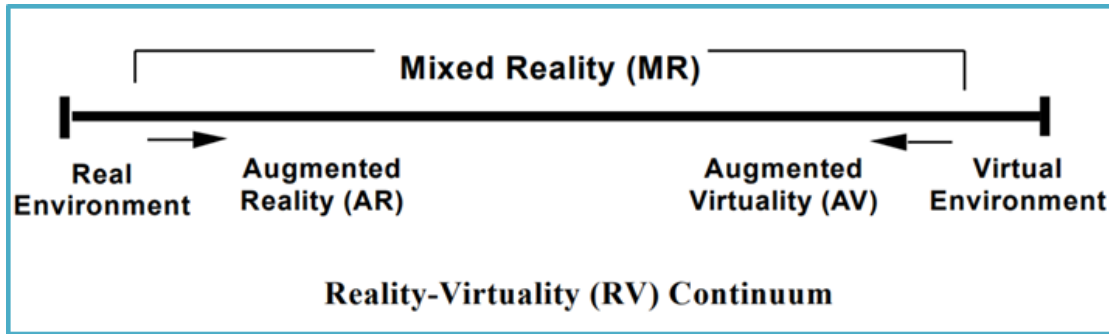


FIGURE 2.2: Milgram and Kishino's Reality-Virtuality Continuum [2, p. 3]

are totally immersed in a fully computer-generated three-dimensional (3D) world, where the features of the real-world environment may or may not be replicated [43]. To be fully immersed in a VR experience, participants have to wear a head-mounted display (HMD). HMDs, provide a first-person perspective where participants are completely surrounded by the virtual world, providing a higher level of immersion in contrast to desktop platforms [3]. As declared by Slater and Wilbur [44, p. 3], the level of immersion describes “the extent to which the computer displays are capable of delivering an inclusive, extensive, surrounding, and vivid illusion of reality to the senses of a human participant”. Finally, HMDs are also commonly used to provide the user with access to an immersive MR or AR experience by combining real and virtual objects. As declared by Milgram and Kishino, a MR experience blends objects from the real world and virtual world within a single display, and an AR experience represents a real environment augmented by virtual objects [2].

## 2.2 Virtual Human Role-Players

VHs have shown to be effective tools for training, education, and research [4, 45, 46]. In clinical psychology, VHs have seen a range of beneficial uses treating patients with depression and anxiety [39, 47]. Many investigations have also found that VH role-players represent a useful training tool for teaching social skills in the areas of communication (Fig. 2.3), leadership (Fig. 2.4) and negotiation [3, 4, 41, 48, 49].

Many authors have identified the benefits of using virtual human role-players. Gratch et al. [50], found that VH role players have demonstrated to make people, practicing social skills, feel more comfortable than human role players. Storey et al. consider

that VH role-players can also be customized to fit diverse scenarios and social contexts, providing a robust learning experience [51]. Finally, VHs do not get tired, and they are always available for trainees to put into practice their skills [3]. As considered by Hartholt et al. [45], VHs have moved from laboratories to become valuable tools in different areas, including social skills training, military training, cognitive science studies, medical training, and entertainment.



FIGURE 2.3: A trainee practicing social skills while giving a presentation in front of a conference of virtual humans [3, p. 126]



FIGURE 2.4: Life-sized virtual subordinate [4, p. 4]



## 2.3 Situational Leadership<sup>®</sup> II

The Situational Leadership<sup>®</sup> (SL<sup>®</sup>) model was initially developed by Dr. Paul Hersey and Kenneth Blanchard in the late 1960s [52]. However, it was not until the 1972 edition of *Management of Organizational Behaviour* that Hersey and Blanchard used the concept for the first time to describe their leadership approach [53]. The main idea behind SL<sup>®</sup> is that there is no single best style of leadership; the best style will depend on the situation. Hence, leaders should be flexible and able to diagnose the situation before selecting the appropriate leadership style [52].

During the late 1970s, the SL<sup>®</sup> model was reviewed to address areas that needed improvement, and it was changed based on extensive feedback from clients and colleagues at Blanchard Training and Development, Inc. [53]. The revised model was then called Situational Leadership<sup>®</sup> II (SLII<sup>®</sup>), first published in a series of three articles that Blanchard wrote for *Executive Excellence* during January-March 1985, and later that year, presented in the book *Leadership and the One Minute Manager* by Kenneth Blanchard, Drea Zigarmi and Patricia Zigarmi [53].

SL<sup>®</sup> and SLII<sup>®</sup> have significant similarities; they both define the development level of followers and the leadership styles required from leaders to best approach the situation. However, the revised SLII<sup>®</sup> model is the one used in the present investigation because its framework builds on the SL<sup>®</sup> model, providing a more meaningful name to the development levels, and representing a more practical, easy-to-understand approach [5]. Congruently, this study aims to provide a robust training experience using a popular and well-supported leadership model with defined leadership styles and a structured opportunity to practice applying the main concepts. As reported in Zigarmi & Roberts [54, p. 244], “the situational leadership model has been one of the most long-standing, widely recognized, and popular leadership models”.

The SLII<sup>®</sup> framework proposes four leadership styles and four follower development levels (Fig. 2.5). Zigarmi et al. [52, pp. 2-3] describe the leadership styles and development levels as follows:

The four Leadership Styles are:

- Directing (S1); high directive and low supportive behaviors

- Coaching (S2); high directive and high supportive behaviors
- Supporting (S3); low directive and high supportive behaviors
- Delegating (S4); low directive and low supportive behaviors

The four Development Levels are:

- Developing (D1); low competence and high commitment
- Developing (D2); some to low competence and low commitment
- Developing (D3); moderate to high competence and variable commitment
- Developed (D4); high competence and high commitment

### Situational Leadership® II Model

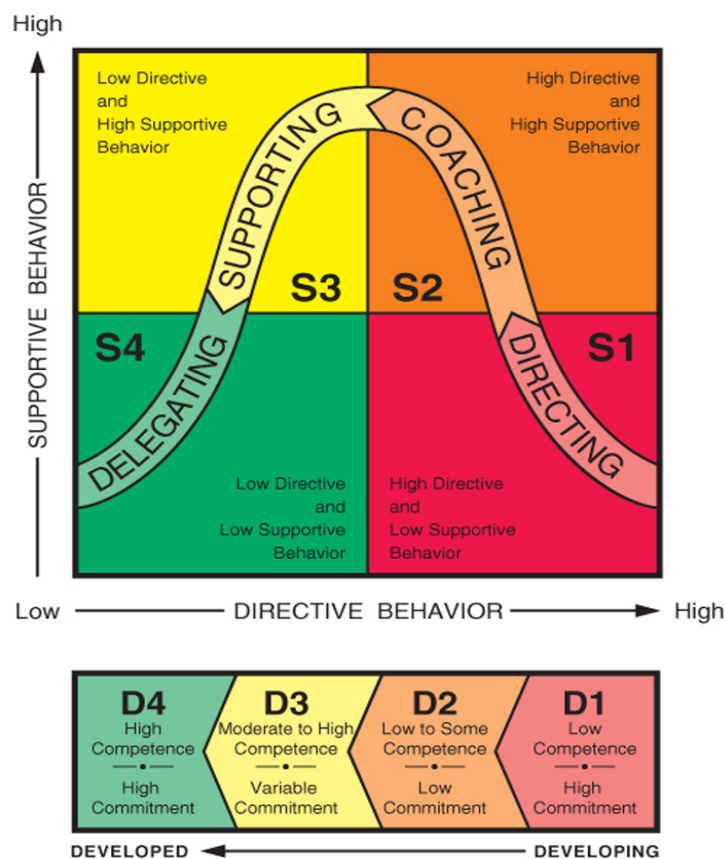


FIGURE 2.5: Situational Leadership® II Quadrant [5, p. 88]

On the one hand, the leadership styles (S1, S2, S3, S4) consist of a combination of a directive (initiating structure) and supportive (consideration) behaviors [52]. Directive behaviors are defined as “the extent to which the leader engages in one-way communication; spells out the follower(s)’ role and tells the follower(s) what to do, where to do it, when to do it, and how to do it; and they closely supervise performance”. Supportive behaviors are defined as “the extent to which the leader engages in two-way communication, listens, provides support and encouragement, facilitates interaction, and involves followers(s) in decision making” [55, p. 6]. On the other hand, the development levels (D1, D2, D3, D4) consist of a combination of competence (skills) and commitment (motivation). Hersey et al. [56, p. 194] define competence as “the knowledge, experience, and skills that an individual or group brings to a particular task or activity”, and commitment as “a combination of motivation, energy, and confidence”.

The four leadership styles are driven based on the development level of the followers in regards to a specific task. According to Blanchard et al. [5], the leadership styles need to be reflected in followers’ level of competence and commitment. According to the SLII<sup>®</sup> model, and as mentioned previously in SL<sup>®</sup>, best leaders should be flexible and match their leadership style based on the situation (development level) to promote performance and ensure satisfaction from their followers [52]. As recognized by Zigarmi et al. [55, p. 6], “this model puts leadership style flexibility at the top of the list for leadership effectiveness”.

To finalize this chapter, we have identified that the development of leadership skills has become a critical talent acquisition. Leadership and communication skills are considered the most valuable professional skills an employee can have. However, social skills are also some of the most challenging skills to teach and practice. Given the time-tested nature of the SLII<sup>®</sup> model, and the effectiveness of VHS, we explored a way of combining them, in order to create a validated approach that is as effective as RH role-play, but with the greater configurability provided by VHS. We then tested the idea empirically to assess the effectiveness.

## Chapter 3

# Prototype Development

This chapter describes the design and implementation of our experimental platform. The prototype was developed to provide an interactive experience with either real or virtual humans during structured role-plays developed with SLII<sup>®</sup> content.

### 3.1 Branching Narrative Design

During structured role-plays, participants are given the context and answers of the instruction, so they are not required to improvise their responses. For this study, we decided to use role-plays with structured narratives to ease, guide, and provide consistency during all the interactions with either real or virtual humans. The first structural concept involved the creation of a low fidelity prototype in which we represented a basic interaction with a branching narrative. The design was organized by the following sections; introduction, follower presentation, answer selection, follower response, and feedback. Both sections *answer selection* and *follower response* are classified for the purpose of this study as *one level of interaction*. Fig. 3.1 shows the structure of the low fidelity prototype. The final prototype followed a similar pattern. However, we decided to include after the introduction section, a brief description of the follower. We also included four levels of interaction under each scenario to provide a wider range of choices. The final structure that we used to build the scenarios can be seen in Fig. 3.2. The sequence moved from left to right, starting with an introduction to the scenario, basic information about the follower, follower presentation, to then continue to the first,

second, third, and fourth level of interaction. The sequence ends with the feedback section.

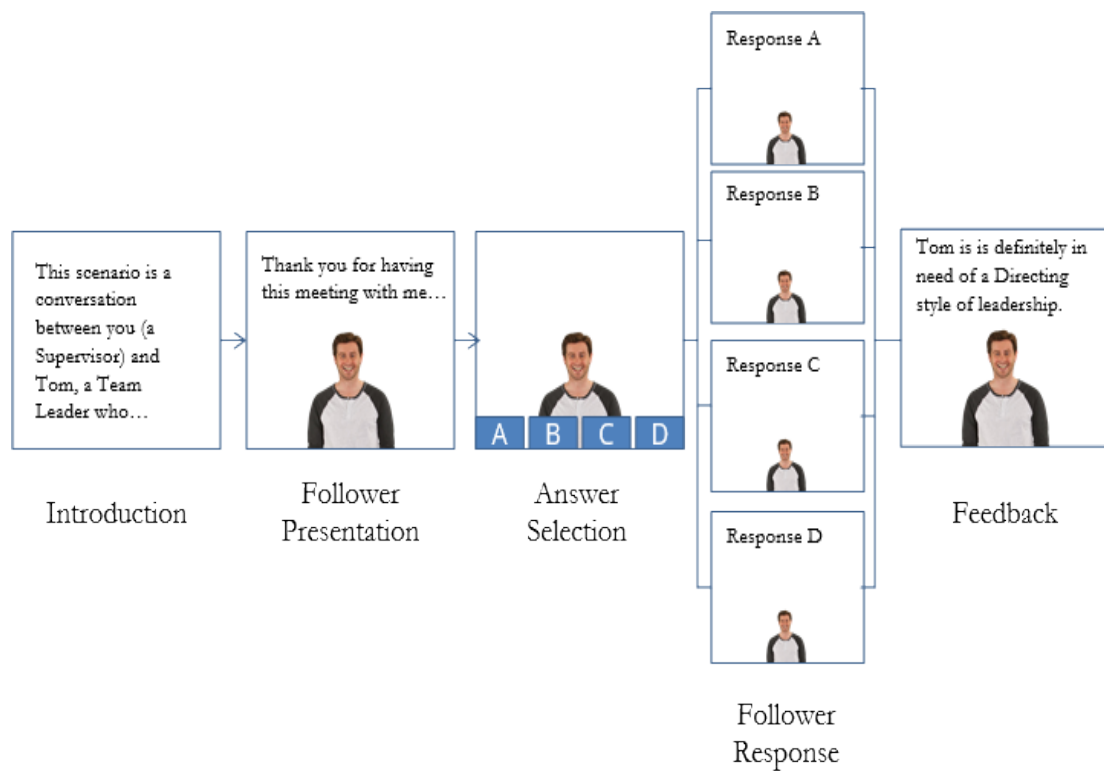


FIGURE 3.1: Branching narrative structure - Low fidelity prototype

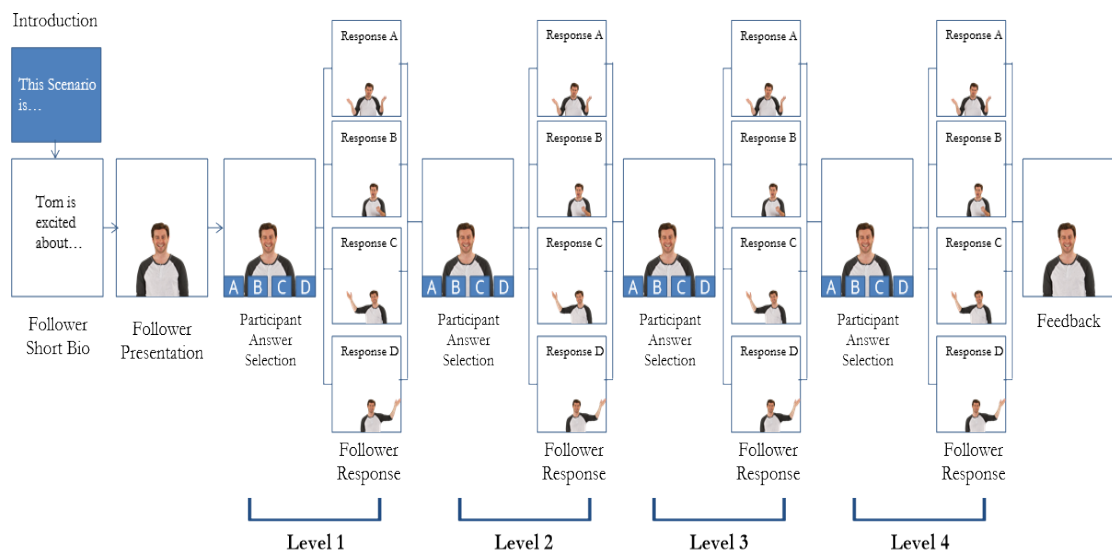


FIGURE 3.2: Branching narrative final structure design

### 3.2 Virtual Human Design

For the creation of virtual humans, we decided to use Adobe Fuse CC<sup>1</sup> due to the photorealistic appearance of the 3D characters. As declared by Volante et al. [57], virtual human appearance can affect the user's emotional reactions and perceptions. Thus, the appearance of virtual humans was considered a relevant aspect to investigate. Furthermore, we provided two virtual humans (one male and one female), as we only counted with the support of two students (male and female) to act as followers under the real human condition. However, we changed the outfit and facial expressions of the virtual humans between scenarios to give a diverse impression. The Fig 3.3 shows the final characters using Adobe Fuse CC.



FIGURE 3.3: VHs developed using Adobe Fuse CC

Once the virtual characters were designed on Adobe Fuse CC, we imported the models into Mixamo<sup>2</sup> to provide a fully rigged skeleton and facial blendshapes for movement. The final animation of virtual humans was achieved after importing the models into

<sup>1</sup>Adobe Fuse CC: <https://www.adobe.com/products/fuse.html/>

<sup>2</sup>Mixamo: <https://www.mixamo.com/>

Unity (2019.2.12f1) game engine on an Alienware desktop equipped with an Intel i7-8700K CPU @ 3.70GHz, 32GB RAM, and an NVIDIA GTX 1080 Ti. We used an HTC Vive Pro HMD<sup>3</sup> with two controllers, three HTC Vive trackers<sup>4</sup>, and the Unity plugin final inverse kinematics (Final IK) to animate the virtual characters (Fig. 3.4). For the facial expressions, we used the Unity plugin SALSA from Crazy Minnow Studio. SALSA provided lip-sync and random eye movement. The next stage involved the recording of the animations with audio. Finally, we organized the animation recordings in a logic structure or finite state machine. The state machine diagram can be seen in Fig. 3.5. The eight scenarios used for this experiment followed the same pattern as we showed before in Fig. 3.2. The sequence moved from left to right starting with the introduction section (follower's bio and presentation), moving to the first transition (level 1), and so on. In the diagram, S1, S2, S3, and S4 stand for the four SLII<sup>®</sup> leadership styles. L1, L2, L3, and L4 stand for the number of interaction levels. The final transition (feedback) represents the end of the interaction.

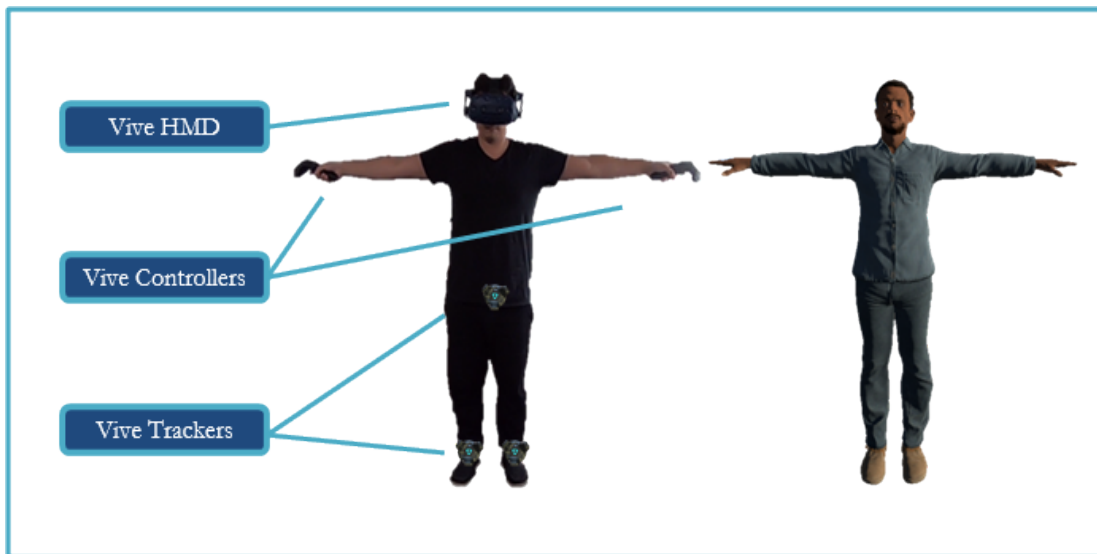


FIGURE 3.4: Virtual Human animation process

<sup>3</sup>HTC Vive Pro HMD: <https://www.vive.com/nz/product/vive-pro/>

<sup>4</sup>HTC Vive Tracker: <https://www.vive.com/nz/vive-tracker/>

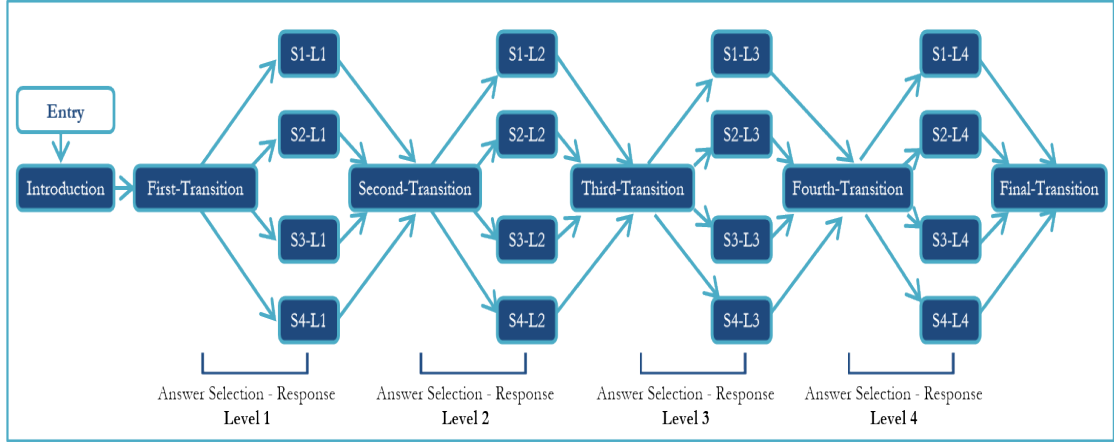


FIGURE 3.5: Finite state machine and the four levels of interaction

### 3.3 VR & MR Environments

Two computer-generated environments (VR, MR) were used to render the interaction with virtual humans. We used an HTC Vive Pro HMD to render both the VR and MR experiences. To provide a video see-through based MR experience, we attached a stereo camera, a ZED Mini<sup>5</sup>, in front of the HMD (Fig. 3.6), as Jung et al. implemented [58, 59]. The combination of the HMD and the ZED mini allowed us to create an experience where real and virtual content was merged seamlessly. The Vive Pro HMD has a resolution of 1440x1600 pixels (per eye), a refresh rate of 90 Hz, a field of view of 110 degrees, and integrated headphones. The high resolution of the Vive Pro was considered a crucial aspect for the experiment, as the interactions required the participants to read paragraphs and short sentences. Therefore, the quality of the image was essential. Moreover, with the intention to match the characteristics of all three conditions, we used in the VR experience a 3D representation of the physical room where the experiment was conducted. The 3D model was scaled to have similar dimensions to the physical room. Both rooms real and virtual can be seen in Fig. 3.7. Finally, we had one last relevant consideration at the time to develop the environments. Users were able to see their bodies during the real human and mixed reality experiences. However, they were not able to see their body during the VR experience. To overcome that problem, we proposed a simple solution that involved the creation of a third virtual character. This character was only used in the VR experience to provide a similar sense of embodiment, to the one experienced by participants in the RH and VH-MR conditions. Participants

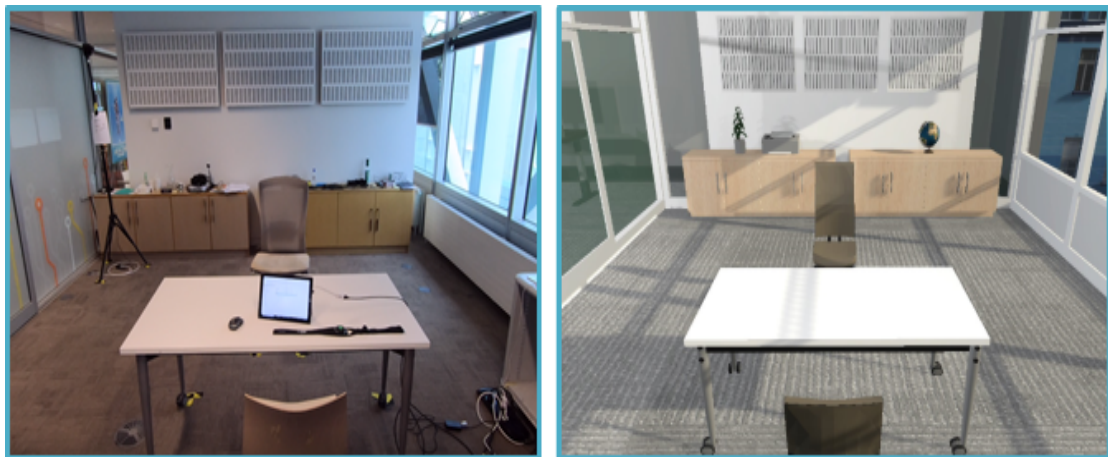
<sup>5</sup>ZED Mini: <https://www.stereolabs.com/zed-mini/>



in the VR condition were able to move the arms of the character (avatar) using the Vive controllers. Fig. 3.8 shows a first-person view of the avatar.



FIGURE 3.6: ZED Mini attached to the HTC Vive Pro



Real Room

Virtual Room

FIGURE 3.7: Real and virtual rooms



FIGURE 3.8: First-person view of the avatar in the VH-VR condition

### 3.4 Real Human Interaction Design

The VH-VR and VH-MR interactions were commanded and guided by the state machine presented above (Fig. 3.5). That logic structure, made with Unity, allowed the automation of all the responses and animations of the virtual humans triggered by participants' answer selection. To manage the narratives of the real human interaction, we used Articulate Storyline<sup>6</sup>, an elearning-authoring platform for instructional designers. Using Storyline, we were able to design a computer application with a logic structure similar to the one used for the VHs. All the narratives were triggered by answer selection, and both leaders (main participants) and followers (a person who reports to the leader) were informed simultaneously as the narrative was changing. The role of the followers was performed by two students (male and female), recruited as training collaborators using the same channels described in Chapter 4. These students were only required to perform under the real human condition, they were not under evaluation, and received a \$10 voucher for their participation. The advertisement can be seen in Appendix A.

### 3.5 Training Content

The Ken Blanchard Companies Inc<sup>®</sup> via Blanchard New Zealand granted authorization to use SLII<sup>®</sup> content for this study. The letter of the agreement can be seen in

<sup>6</sup>Articulate Storyline: <https://articulate.com/360/storyline/>

Appendix C. The scenarios were developed using the *SLII® Conversation Starters* section from the *Participant Kit Material*<sup>7</sup>. Furthermore, we relied on the support of an accredited SLII® Certified Trainer, who monitored the development of the scenarios providing advice, and acting as a facilitator providing the key concepts of the SLII® model to participants in all three conditions. Having considered the logistic problem of requesting the certified trainer to be present for thirty different sessions (one for each participant), we decided to film the instruction and deliver it in video format.

The scenarios were structured based on the development level of the follower. The first four scenarios, presented to the participants during the pre-test, are organized as D1, D2, D3, and D4. The next four scenarios, presented to the participants during the post-test, are organized using the same order. Following the SLII® framework, the narrative for the scenarios D1 was built having in mind followers (Alice and Jack) with low competence and high commitment, in need of a directive style of leadership (S1). For the scenarios D2, the followers (Tom and Margaret) have low to some competence and low commitment, in need of a coaching style of leadership (S2). For the scenarios D3, the followers (Denise and Anton) have moderate to high competence and variable commitment, in need of a supporting style of leadership (S3). Finally, for the scenarios D4, the followers (Peter and Stacey) have high competence and high commitment, in need of a delegating style of leadership (S4). The eight scenarios can be seen in Appendix C.

### 3.6 Implementation

The study was conducted in a dedicated experiment room (Student Lab) at the HIT Lab NZ, John Britten building, University of Canterbury, NZ. We prepared three different setups according to each condition. The setups can be seen in Fig. 3.9, Fig. 3.10, and Fig. 3.11.

In the RH condition, we used a Microsoft Surface equipped with an Intel i5-4300U CPU @ 1.90Ghz with 4GB RAM. A 32-inch television, and Bluetooth earbuds (tiny speakers). We ran the Storyline application with the Surface, allowing us to organize more efficiently the branching narratives of the eight scenarios. The touch screen of the Surface was used first, to match the way how answers were selected in all three

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<sup>7</sup>©Copyright The Ken Blanchard Companies Inc. All rights reserved. Limited permission granted in 2019 by Blanchard NZ to Gonzalo Suarez for study use only

conditions, and second, the tactile input allowed to keep a record of the answers chose by participants. The 32 inch TV and Bluetooth earbuds were used to support followers with their narratives. The followers' script was transmitted through text and audio, and it changed automatically according to the answers selected by participants. The TV was set up behind the main participants (leaders) and visible to the followers, so they were able to read their script if it was required. Simultaneously, audio feedback was reproduced through the Bluetooth earbuds. Followers wore the earbuds in all the interactions.



FIGURE 3.9: Real Human setup

Participants in the VH-VR condition required both controllers to move the arms of the avatar, as discussed above. The white desk located at the center of the room had to be moved for the VH-MR condition, as it was affecting the rendering of the virtual humans due to an occlusion problem. However, we rendered a virtual desk in replacement. A virtual pointer was incorporated as an extension of one of the controllers. Participants only had to point the controller in the direction of the chosen answer and press the trigger button on the controller to confirm the selection. Both experiences were rendered using a desktop equipped with an Intel i7- 8700 CPU @ 3.20GHz, 32GB RAM, and an NVIDIA RTX 2080. Fig. 3.12 shows the answer selection.

We used in all three conditions a 52 inch TV, a Zephyr Bioharness heart-rate device, and two cameras; a webcam and a GoPro Hero 7. As shown in Fig. 3.13, the 52 inch



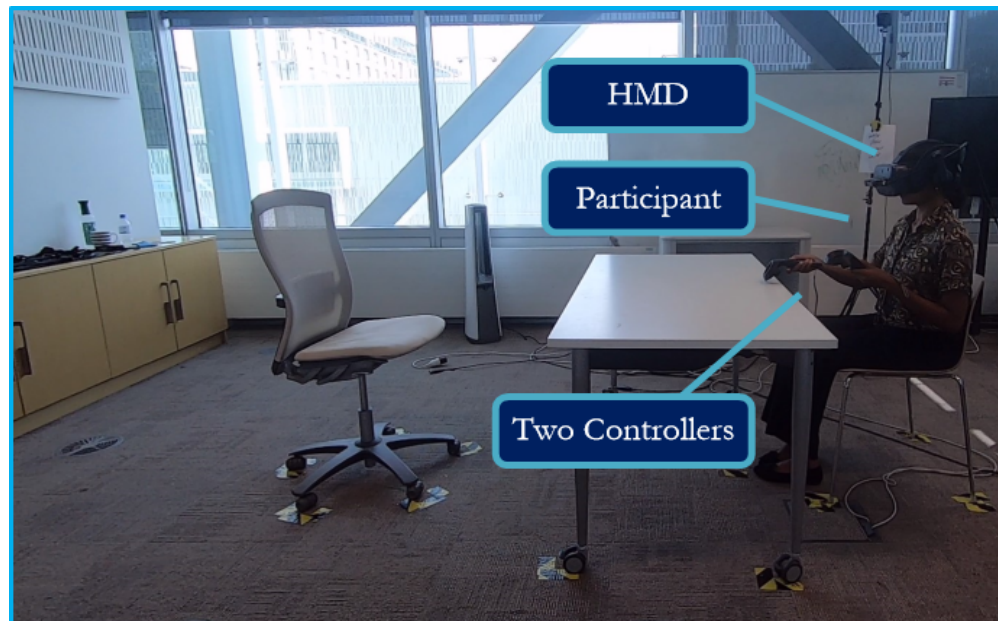


FIGURE 3.10: Virtual Human VR setup

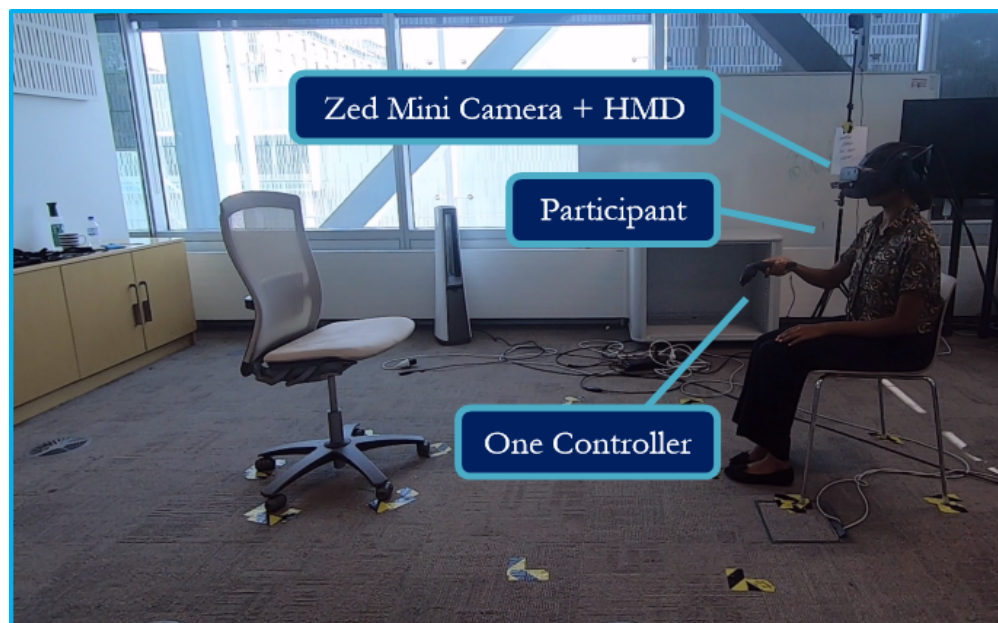


FIGURE 3.11: Virtual Human MR setup

TV was used to play the information-based video, where an accredited SLII<sup>®</sup> Certified Trainer provided the key concepts of the model. Participants wore headphones during the video to reduce the number of distractions (e.g., environmental noise). Participants were also asked to wear a chest strap with the Zephyr BioHarness<sup>8</sup> heart-rate device, which was used for the recording of the heart rate and heart rate variability during the role-plays. The setup of the BioHarness can be seen in Fig. 3.14

<sup>8</sup>Zephyr Heart-rate sensor: <https://www.zephyranywhere.com/>



(a) HTC Vive controller



(b) Pointer answer selector

FIGURE 3.12: Answer Selection in the VH-VR, and VH-MR conditions



FIGURE 3.13: SLII Information-based session

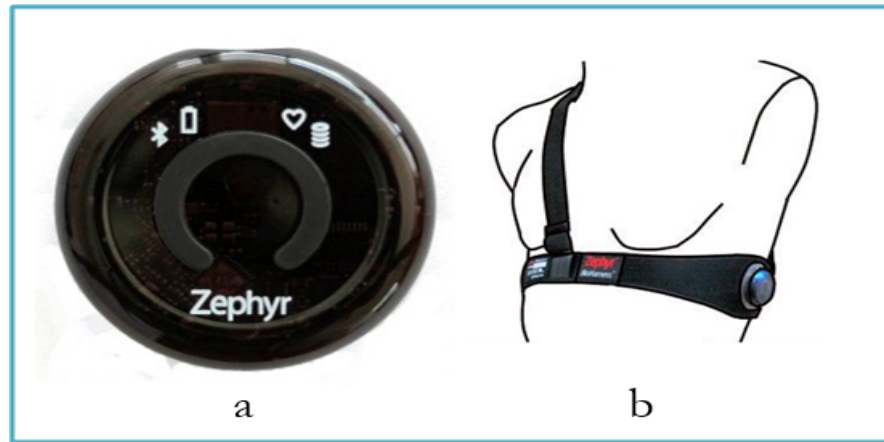


FIGURE 3.14: (a) BioHarness module (b) BioHarness module attached to chest strap

### 3.7 Pilot Study

To verify our system's functionality before we ran the actual study, we conducted a pilot study with three participants. Each participant was assigned to one condition only. During the pilot study, it was found that it was distracting to the users to hear the recording of their voices immediately after reading aloud their answers. This only happened under the conditions in interaction with VHS where an HMD was used to render the experience. The HTC Vive Pro HMD comes with integrated headphones and microphone. The microphone (input) was used to capture the voice while recording the audio coming from the headphones (output). To solve this problem, we used a free and open-source platform called Open Broadcaster Software<sup>9</sup> (OBS), which allowed us to re-direct the output audio from the headphones to the speakers of the computer used to run the experience. The data collected from the pilot study was not included in the final data.

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<sup>9</sup>OBS: <https://obsproject.com/>

## Chapter 4

# User Evaluation

This chapter describes a user study experiment conducted to evaluate the effectiveness of VH role-players to practice and develop leadership skills in different computer-generated environments.

### 4.1 Study Design

We conducted a 3x2 mixed factorial design with the two independent variables. One factor had three levels, and the other factor had two levels, so we had six conditions in total, as shown in Table 4.1. The first factor called *Group* was a between factor. The second factor called *Time*, was a within factor. Participants were randomly assigned to one of three groups.

<b>Group</b>	<b>Time</b>	
	Pre-Test	Post-Test
Real Human Interaction	A1	A2
Virtual Human Interaction in VR	B1	B2
Virtual Human Interaction in MR	C1	C2

TABLE 4.1: Factorial design



## 4.2 Participants

For the experiment, 30 participants were recruited through the University of Canterbury's social network pages, and advertisements (Appendix A) posted on billboards around the campus. Among the 30 participants, 18 (60%) were males, and 12 (40%) were females. Participants' age varied between 22 to 70 years ( $M = 35.0$ ,  $SD = 11.51$ ). The experiment was conducted with the approval of the University's Human Ethics Committee (Appendix A). All participants, considering the possibility of being Māori, were treated respectfully and asked for permission if there was a need to touch the *upoko* (head) when positioning or adjusting a virtual reality headset. A letter on behalf of the Ngāi Tahu Consultation and Engagement Group (NTCEG) can be found in Appendix A. Participants received a \$15 voucher for their participation.

## 4.3 Procedure

Overall, the experiment took approximately 50 minutes. The procedure is described below:

1. At the beginning of the experiment, participants were given a general overview and explanation of the project. This was followed by an information sheet and the consent form to read and sign. The information sheet and the consent form are provided in Appendix A.
2. They were then given two pre-experiment questionnaires to answer, a demographic questionnaire and a pre-test Dundee Stress State Questionnaire (DSSQ) which can be found in Appendix B.
3. After completing the pre-experiment questionnaires, participants were given detailed instructions about the experiment and how to perform the experimental tasks. Then, they were asked to wear a chest strap with a heart rate monitor (Fig. 3.14) used to measure and compare stress indicators during the interactions.
4. At this point, participants were ready to start the experiment according to the interaction group to which they were randomly assigned. Before the experiment started, a video camera was prepared for the recording of the interactions (the purpose of the video recording was only for post-analysis of verbal and non-verbal responses).
5. After completing the experience, participants were asked to answer four post-experiment

questionnaires, a post-test Dundee Stress State (DSSQ), a social presence scale, and Kirkpatrick's level one (reaction) and level two (learning).

6. Lastly, there was a debriefing session where participants receive clarification to questions they may have had. Then, they were asked for their feedback.

## 4.4 Experimental Task

Participants were assigned to a condition in a counterbalanced order, and they were asked to perform as leaders (e.g., Manager, Supervisor, Director, etc.) during eight structured role-plays built with branching narratives based on the SLII<sup>®</sup> model. The participant's main task was to guide or command eight followers (one per scenario), using the best matching leadership style. A follower means someone who reports directly to the leader (e.g., a team leader, a teacher, a sales representative, etc.). Participants in the RH group interacted with live humans, and participants in the VH-VR group and VH-MR group, interacted with virtual humans wearing a VR HMD and MR HMD, respectively. The interactions and tasks can be seen in Fig. 4.1, Fig. 4.2, and Fig. 4.3. The tasks of the three groups can be classified using the following structure:

**Pre-Test:** During this stage, participants were asked to complete four SLII<sup>®</sup> scenarios. The narrative of each scenario was structured based on the development level of the follower or person to be guided or commanded. The scenarios were presented to the participants in the order: D1, D2, D3, and D4. Participants were informed to begin by reading the introduction section at the beginning of each scenario. The introduction section provided relevant information about the scenarios and followers to put participants into context. Then, the follower sitting in front (RH or VH) began his/her narrative. Once the follower finished his/her part of the script, participants then were asked to select a response from one of the four pre-scripted answers displayed in front of them. Participants were told to select the answer they considered the best according to the follower's narrative. They were also asked to say aloud their chosen answers and then make the final selection by touching a button on a screen (RH group), or pointing and pressing a control button (VH groups). The narrative continued after answer selection. Each scenario ended with feedback describing the best approach to be taken according to the development level of the followers. Once four scenarios were completed, participants continued to the next stage.

**SLII® Information-based Session:** During this stage, participants from all conditions were asked to sit in front of a physical 52 inch TV and watch a 20-minute video where an Accredited Certified Trainer in Situational Leadership® II provided the fundamental aspects of the SLII® model. Then, participants continued to the final stage of the experiment.

**Post-Test:** During this stage, participants were asked to repeat the same steps from the pre-test. However, they were introduced to four new SLII® scenarios with different narratives to prevent the impact of learning effects. The scenarios were presented to the participants in the order: D1, D2, D3, and D4.



FIGURE 4.1: RH group experimental tasks



FIGURE 4.2: VH-VR group experimental tasks



FIGURE 4.3: VH-MR group experimental tasks

## 4.5 Measures

For this experiment, we propose the following measures to evaluate the effectiveness of virtual humans, and the reaction and degree of confidence and commitment participants have after the training experience: learning performance, stress levels, social presence, and overall training experience.

### 4.5.1 Learning Performance

We assessed the learning performance by the number of matches or mismatches obtained by participants during the interactions with either RHs or VHs. According to the SLII<sup>®</sup> model, leaders should be able to match their leadership style to the development level of the follower. Therefore, if the development level of the follower is D1 (low competence and high commitment), we expect the leader to approach the follower with a leadership style S1 (high directive and low supportive behavior). We designed for that purpose, a total of eight structured role-play scenarios using the framework of the SLII<sup>®</sup> model. All the scenarios were built with branching narratives triggered by response selection. Participant's responses were scored: +2, +1, -1, and -2. Positive scores are associated with the answers required to match (+2) or close to match (+1) the development level of the follower. Similarly, negative scores are associated with the answers that represented the opposite or a mismatch. As an example, as we have mentioned in Chapter 2, leader styles consist of a combination of directive and supportive behavior [52], and that combination could vary between S1, S2, S3, and S4. When D1 (low competence and

high commitment) represents the development level of the follower, S1 (high directive and low supportive behavior) represents the appropriate leadership style. However, as the D1 follower still requires direction, the leadership style S2 (high directive and high supportive behavior) is not completely incorrect. When that is the case, we evaluated the response as +1, and we used the same logic for the negative scores. Participants were asked to select a total of four possible answers per scenario. Therefore, we have a total of 32 chosen answers during the pre-test and post-test levels, with a total score ranging from 64 points (highest score) to -64 points (lowest score). The scores obtained during the pre-test and post-test levels represent the measure used to evaluate the learning performance.

#### **4.5.2 Stress Levels**

Gratch et al. stated that people felt more comfortable when practicing interpersonal skills with VH role-players rather than with human role-players [50]. Therefore, we considered relevant for this experiment to evaluate the stress levels experienced by participants during the interaction with either RHs or VHs. We used two measures to provide a robust analysis of the stress levels, a Zephyr Bioharness heart-rate monitor, and the Dundee Stress State Questionnaire (DSSQ). The Zephyr Bioharness has proven reliability measuring physiological data across multiple contexts [60]. Similarly, the DSSQ is a proven tool for assessing the main subjective elements of stress during task performance [61].

#### **4.5.3 Social Presence**

Heeter [62] reported that “social presence reflects the degree to which one believes that he or she is in the presence of, and interacting with, other veritable human beings”. With the arrival and evolution of more advanced telecommunications technologies, the presence of others can now be perceived either face-to-face or mediated by technology. However, some researchers [63, 64] have recognized the absence of many cues in these technologies (e.g., posture, facial expression, mutual eye-gaze, etc.) as affecting the capacity to transmit information and the attention of the users to focus on the presence of others. We have investigated that immersive virtual environments have the potential

to increase the sense of presence in computer-generated environments substantially, allowing VHs to elicit feelings of social presence. Thus, we focused on evaluating social presence as another relevant indicator to measure the effectiveness of VHs. We used the Social Presence scale by Bailenson et al. [33], consisting of five items rated on a Likert-type scale (from -3 to 3). The questionnaire can be found in Appendix B.

#### 4.5.4 Overall Training Experience

The Kirkpatrick model [65] was used to evaluate the overall training experience. The Kirkpatrick model is widely recognized for analyzing and evaluating the results of training (formal or informal). The model consists of four levels of evaluation, namely *reaction* (level 1), *learning* (level 2), *behavior* (level 3), and *results* (level 4). For this study, we only evaluated the first two levels. Level 3 and level 4 were not considered because they can only be evaluated once a long period of time has elapsed. *Reaction* evaluates the extent to which participants find the training beneficial, engaging and appropriate to their main task or jobs. *Learning* evaluates the extent to which participants obtain the proposed learning, confidence, and commitment. For reaction, we used a four-point Likert scale [66] with six items, *program objectives*, *content relevance*, *facilitator knowledge*, *delivery*, *evaluation*, and *facility*. For learning, we used a ten-point Likert scale [67] with two items, *confidence and commitment*.

## Chapter 5

# Results

This chapter presents the results obtained from the experiment. We used quantitative and qualitative measures to collect data from each participant. The quantitative measures consisted of two pre-experiment questionnaires used to collect demographic information and stress levels (DSSQ pre-test). The learning performance, heart-rate, and heart rate variability measured during the role-play interactions. Finally, we used four post-experiment questionnaires to measure participant's stress levels (DSSQ post-test), social presence indicators, and the overall training experience (Kirkpatrick's level 1 and level 2). The qualitative measures consisted of a text-based and multimedia-based information recorded from the participants.

We conducted parametric tests to evaluate the dependent variables learning performance and stress levels. Each variable was analyzed by separately applying a mixed-design analysis of variance (split-plot ANOVA) with the within-factors *pre-post levels* and the between-factor *group*. An analysis of the stress levels was done with the data collected with the Zephyr Bioharness heart-rate device and participants' responses to the DSSQ. The DSSQ has three components: *engagement*, *distress*, and *worry*, each component was analysed separately. The dependent variable social presence was analyzed using a non-parametric Mann-Whitney U test. A Kruskal-Wallis H test was conducted to analyze the scores obtained from the Kirkpatrick's level 1 and level 2 questionnaires.

## 5.1 Demographics

Out of 30 participants, eight said have never been assigned to a leadership position, 12 have been assigned a few times a year, three participants a few times a week, and seven participants said that they were assigned daily. Four participants said they had received training in Situational Leadership® II. Sixteen participants said they have never used an HMD before, 11 have used it a few times a year, and three reported to be more frequent users.

## 5.2 Quantitative Measures

### 5.2.1 Learning Performance

The results are summarized in Table 5.1, which shows the differences in mean scores organized per group. The mixed-design analysis of variance (split-plot ANOVA) showed there were no outliers, as assessed by examination of studentized residuals for values greater than  $\pm 3$ . The data was normally distributed, as assessed by Normal Q-Q Plot. There was homogeneity of variances ( $p > 0.05$ ) and covariances ( $p = 0.403$ ), as assessed by Levene's test of homogeneity of variances and Box's M test, respectively. We found a slight interaction effect between the VH-VR and VH-MR group, but it was not statistically significant (Fig. 5.1) between the groups and pre-post levels on scores values,  $F(2,27) = 1.636$ ,  $p = 0.214$ ,  $\eta_p^2 = 0.108$ . Post hoc analysis with a Bonferroni adjustment revealed that there was an increase in performance scores from the pre-test levels ( $M = 11.0$ ,  $SD = 9.66$ ), to the post-test levels ( $M = 18.4$ ,  $SD = 8.72$ ) in the VH-MR group, a statistically significant mean increase of 7.4, 95% CI [3.59, 11.2],  $p = 0.002$ . Participants in the VH-MR condition obtained better scores ( $M = 29.4$ ,  $SD = 17.62$ ) than participants in the VH-VR condition ( $M = 26.8$ ,  $SD = 11.24$ ), and participants in the RH condition ( $M = 24.1$ ,  $SD = 8.77$ ), but, there was no statistically significant difference in mean scores between groups  $F(2, 27) = 0.410$ ,  $p = 0.668$ ,  $\eta_p^2 = 0.029$ .



	<b>RH</b>	<b>VH-VR</b>	<b>VH-MR</b>
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>
<b>Pre-Test Scores</b>	11.1 (5.95)	12.1 (7.35)	11.0 (9.66)
<b>Post-Test Scores</b>	13.0 (6.21)	14.7 (6.44)	18.4* (8.72)
<b>Differences in Scores</b>	1.9 (0.26)	2.6 (0.91)	7.4 (0.94)

TABLE 5.1: Mean and standard deviation of the pre-test, post-test, and differences in scores organized per group; \*  $p < 0.05$

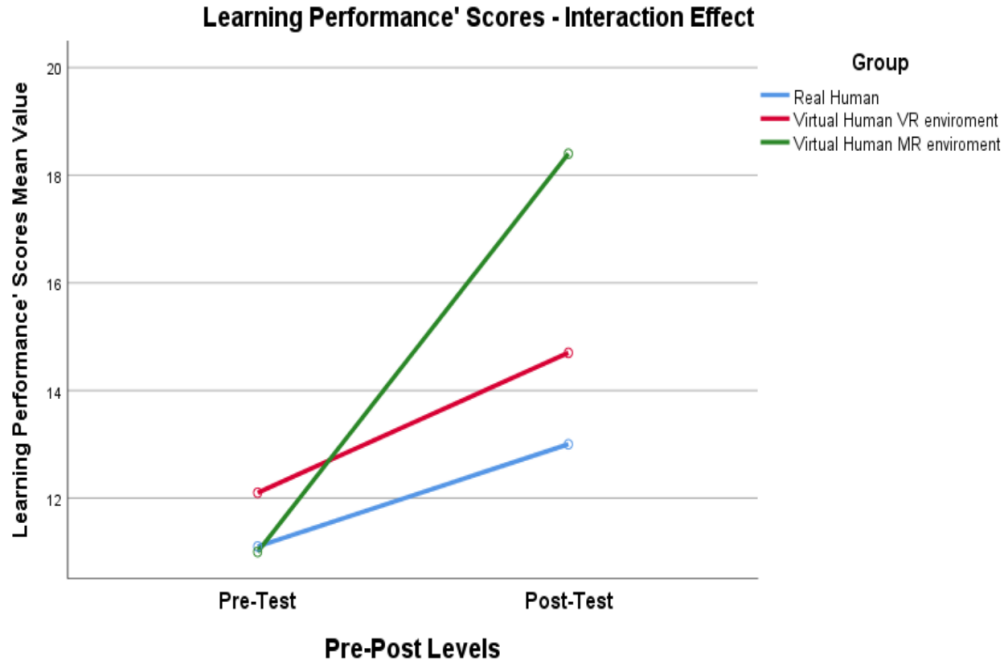


FIGURE 5.1: Learning performance' scores interaction effect

### 5.2.2 Stress Levels

We analyzed the stress levels experimented during the role-plays with the data collected from the Zephyr BioHarness heart-rate device and the DSSQ questionnaire. We recorded changes in the heart rate and heart-rate variability (HRV) in all 30 participants during the role-play interactions. However, we only analyzed the HRV for being considered a more precise indicator of stress levels [68, 69], as described next.

### 5.2.2.1 Heart-Rate Variability

We have summarized the results in Table 5.2, which shows the differences in mean HRV organized per group. The mixed-design analysis of variance (split-plot ANOVA) showed there were no outliers, as assessed by examination of studentized residuals for values greater than  $\pm 3$ . The data was normally distributed, as assessed by Normal Q-Q Plot. There was homogeneity of variances ( $p > 0.05$ ) and covariances ( $p = 0.765$ ), as assessed by Levene's test of homogeneity of variances and Box's M test, respectively. There was no statistically significant interaction (Fig. 5.2) between the groups and pre-post levels on HRV,  $F(2, 27) = 0.384$ ,  $p = 0.685$ ,  $\eta_p^2 = 0.028$ . All three groups had an increase in HRV from the pre-test to the post-test levels, indicating a successful performance on emotion regulation tests, and appropriate recovery to a stressful situation [69], but the main effect showed that there was no statistically significant difference in mean HRV at the different levels,  $F(1, 27) = 3.57$ ,  $p = 0.069$ ,  $\eta_p^2 = 0.117$ . The main effect of group showed that there was no statistically significant difference in mean HRV between groups  $F(2, 27) = 0.030$ ,  $p = 0.971$ ,  $\eta_p^2 = 0.002$ .

	<b>RH</b> <i>M (SD)</i>	<b>VH-VR</b> <i>M (SD)</i>	<b>VH-MR</b> <i>M (SD)</i>
<b>Pre-Test HRV</b>	54.0 (17.92)	54.7 (10.88)	55.1 (12.12)
<b>Post-Test HRV</b>	58.4 (21.46)	55.8 (12.55)	58.7 (17.14)
<b>Differences in Scores</b>	4.4 (7.94)	1.1 (1.67)	3.6 (5.02)

TABLE 5.2: Mean and standard deviation of the HRV pre-test, and post-test, organized per group

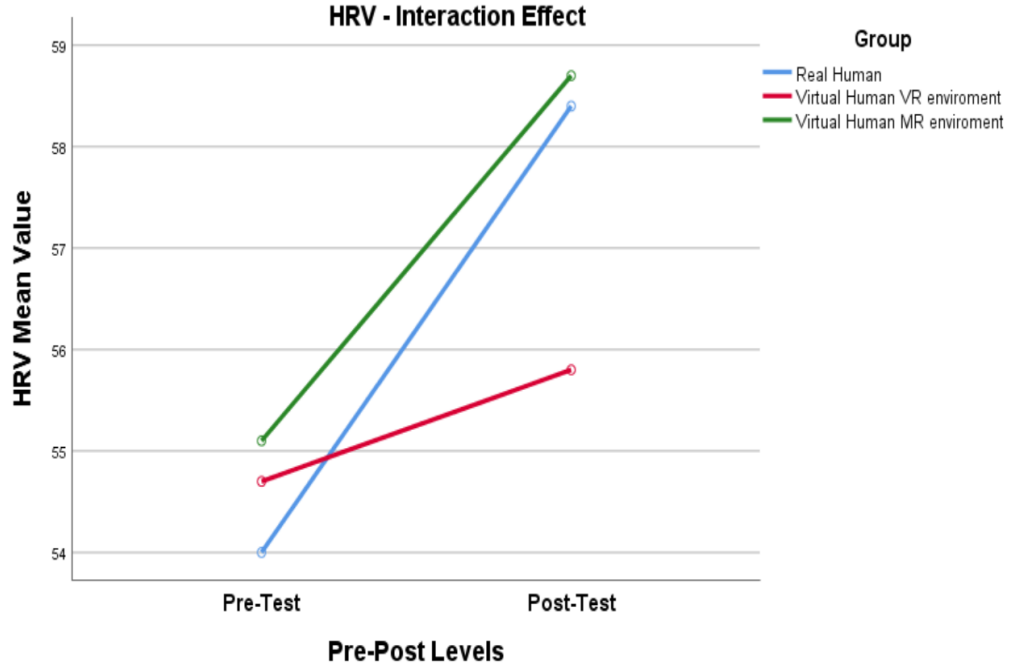


FIGURE 5.2: HRV interaction effect

### 5.2.2.2 Dundee Stress State Questionnaire (DSSQ)

Separate split-plot ANOVAs were calculated for each DSSQ factor. Table 5.3 shows cell means and standard deviations. Changes in factors are summarized in Fig. 5.4, which shows the differences in mean scores organized per group for engagement, distress, and worry during the pre-test and post-test.

There was a statistically significant interaction effect (Fig. 5.3) between the groups and pre-post tests on engagement,  $F(2, 27) = 3.80$ ,  $p = 0.035$ ,  $\eta_P^2 = 0.220$ . All three groups had an increase in engagement scores from the pre-test to post-test levels, but the only statistically significant increase was represented by the VH-MR group ( $M = 3.3$ ,  $SE = 0.578$ ,  $p = 0.001$ ). There was no statistically significant interaction between the groups and pre-post tests on distress,  $F(2, 27) = 0.018$ ,  $p = 0.982$ ,  $\eta_P^2 = 0.001$ . Post hoc analysis with a Bonferroni adjustment revealed that there was a decrease in distress from the pre-test levels ( $M = 8.5$ ,  $SD = 4.27$ ), to the post-test levels ( $M = 6.9$ ,  $SD = 4.01$ ), a statistically significant mean decrease of 1.60, 95% CI [.059, 3.14],  $p = .042$ . Participants in the VH-MR group obtained lower marginal mean for distress ( $M = 6.2$ ,  $SE = 1.13$ ) than participants in the RH condition ( $M = 8.2$ ,  $SE = 1.13$ ), and participants in the VH-VR condition ( $M = 8.7$ ,  $SE = 1.13$ ), but, the difference

was not statistically significant between groups  $F(2, 27) = 1.33, p = 0.281, \eta_p^2 = 0.090$ . There was no statistically significant interaction between the groups and pre-post tests on worry,  $F(2, 27) = 0.579, p = 0.567, \eta_p^2 = 0.041$ . There was no statistically significant difference in mean worry at the different levels,  $F(1, 27) = 0.102, p = 0.752, \eta_p^2 = 0.004$ , and between groups  $F(2, 27) = 0.546, p = 0.585, \eta_p^2 = 0.039$ .

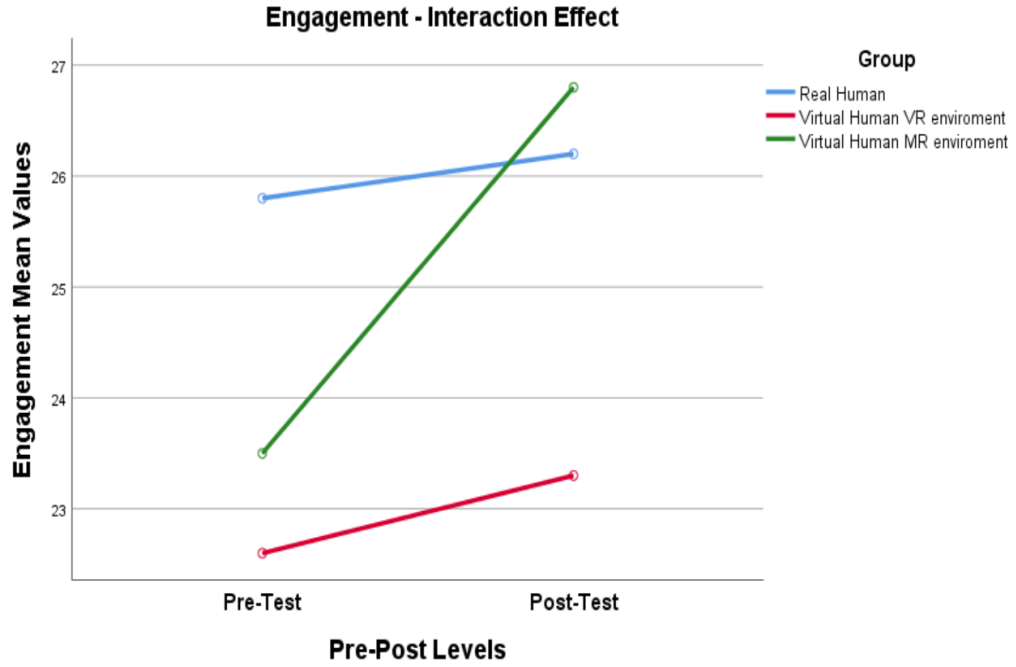


FIGURE 5.3: Engagement interaction effect

		RH	VH-VR	VH-MR
		<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>
<b>Engagement</b>	Pre-Test	25.8 (5.59)	22.6 (4.85)	23.5 (4.50)
	Post-Test	26.2 (4.70)	23.3 (4.73)	26.8* (3.36)
<b>Distress</b>	Pre-Test	8.9 (5.52)	9.6 (2.95)	7.1 (3.98)
	Post-Test	7.5 (4.42)	7.9 (3.47)	5.4 (4.03)
<b>Worry</b>	Pre-Test	13.6 (5.66)	14.5 (4.99)	14.6 (7.24)
	Post-Test	13.3 (4.05)	13.8 (4.41)	16.7 (7.25)

TABLE 5.3: Means and standard deviations of the DSSQ factors during pre-test and post-test organized per group; \*  $p < 0.05$

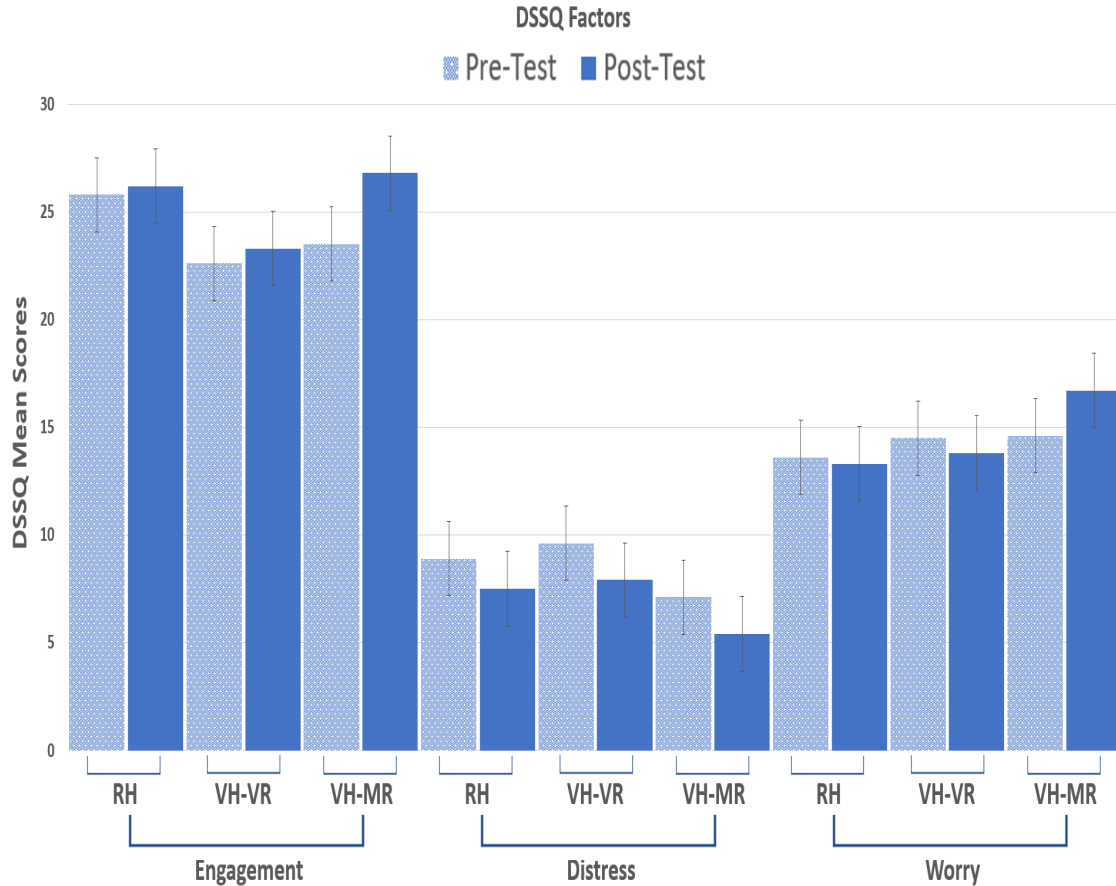


FIGURE 5.4: Pre-test and post-test DSSQ factor scores organized per group. Error bars are standard errors

### 5.2.3 Social Presence

Participant responses were summed to provide an overall social presence score. Thus, social presence was measured as a single dimension concept. Participants in the RH group did not answer the questionnaire. The questionnaire was completed post-experiment, and it can be found in Appendix B.

According to Baileson et al. [33], “a positive presence score indicates that the participants believed the VH was conscious and was watching him or her, whereas a negative score indicates that the participant felt the VH was just a computerized image”. The average social presence rating score was 1.2 ( $SD = 3.68$ ), the minimum score was -6, and the maximum score was 7. Participants in the VH-VR condition reported a greater sense of social presence, obtaining a higher number of positive scores (eight out of ten) in comparison to participants in the VH-MR condition (six out of ten). A nonparametric Mann-Whitney U test was run to determine if there were differences in social presence

score between the groups. The results indicated that social presence scores for the VHs rendered in VR (mean rank = 11.40), and the VHs rendered in MR (mean rank = 9.60) were not statistically different,  $U = 41$ ,  $z = -0.685$ ,  $p = 0.494$ .

## 5.2.4 Overall Training Experience

### 5.2.4.1 Kirkpatrick's Level 1: Reaction

Six factors were measured to evaluate the reaction of the participants to the training experience. The six factors were *program objectives*, *content relevance*, *facilitator knowledge*, *delivery*, *evaluation*, and *facility*. We also summed participant scores to analyze the overall reaction score. Table 5.4 summarizes the results obtained for each factor, and we have also provided a bar chart with the differences in mean scores organized per group in Fig. 5.5. Next, we provide an analysis of both the total reaction score and the scores obtained under each factor.

A Kruskal-Wallis H test was run to determine if there were differences in the total reaction scores between the three groups. Distributions of the total scores were similar for all groups, as assessed by visual inspection of a boxplot. The reaction scores were higher in the RH group ( $M = 20.0$ ) in comparison to the VH-VR group ( $M = 18.9$ ), and the VH-MR group ( $M = 19.1$ ), but the difference was not statistically significant,  $\chi^2(2) = 1.123$ ,  $p = 0.570$ . For the scores obtained under each factor, the RH group obtained the higher score in program objectives ( $M = 4.7$ ), content relevance ( $M = 2.3$ ), facilitator knowledge ( $M = 2.3$ ), and delivery ( $M = 4.9$ ). The VH-VR group obtained a higher score in evaluation ( $M = 2.0$ ), and the VH-MR group obtained a higher score in facility ( $M = 5.0$ ). There were no statistically significant differences between factors and groups.

	<b>RH</b> <i>M (SE)</i>	<b>VH-VR</b> <i>M (SE)</i>	<b>VH-MR</b> <i>M (SE)</i>
<b>Program Objectives</b>	4.7 (0.30)	4.4 (0.22)	4.6 (0.26)
<b>Content Relevance</b>	2.3 (0.21)	2.0 (0.21)	1.9 (0.27)
<b>Facilitator Knowledge</b>	2.3 (0.15)	2.3 (0.15)	1.7 (0.33)
<b>Delivery</b>	4.9 (0.34)	4.2 (0.41)	4.0 (0.53)
<b>Evaluation</b>	1.5 (0.16)	2.0 (0.21)	1.9 (0.23)
<b>Facility</b>	4.6 (0.40)	4.0 (0.33)	5.0 (0.33)

TABLE 5.4: Means and standard errors of the reaction factors organized per group

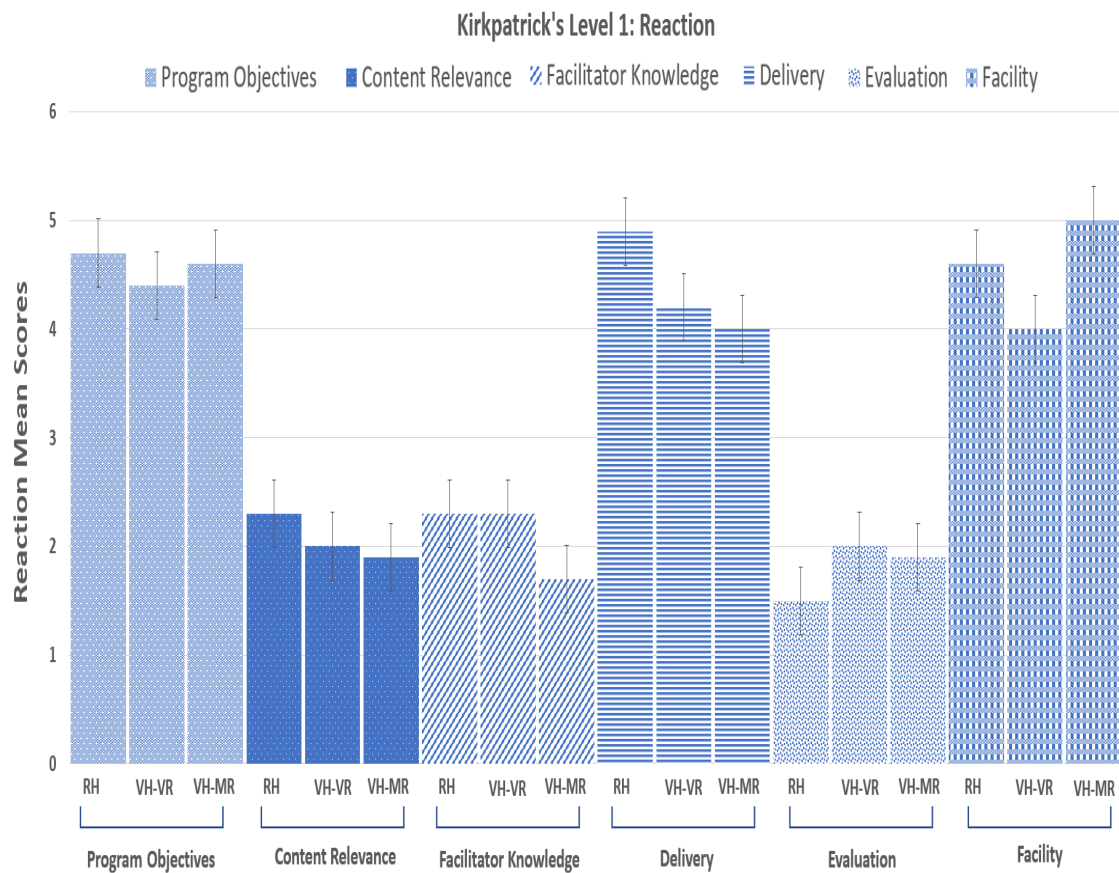


FIGURE 5.5: Reaction factor scores organized per group. Error bars are standard errors

### 5.2.4.2 Kirkpatrick's Level 2: Learning

Changes in factors are summarized in Fig. 5.6, which shows the differences in mean scores organized per group for confidence, and commitment during the pre-test and post-test. The 10-point Likert-scale used to evaluate learning consisted of two items. The first item was used to evaluate the degree of *confidence* the participants had to apply what they have learned. The second item evaluated the degree of *commitment* the participants had to apply what they have learned. Each item was analyzed separately to determine if there were differences between groups using Kruskal-Wallis H tests. The results showed that all three groups obtained high scores in both items, indicating a high degree of confidence and commitment to apply what was learned. Median scores for confidence ( $\chi^2(2) = 2.580, p = 0.275.$ ), and commitment ( $\chi^2(2) = 0.630, p = 0.730.$ ) were not statistically significantly different between groups.

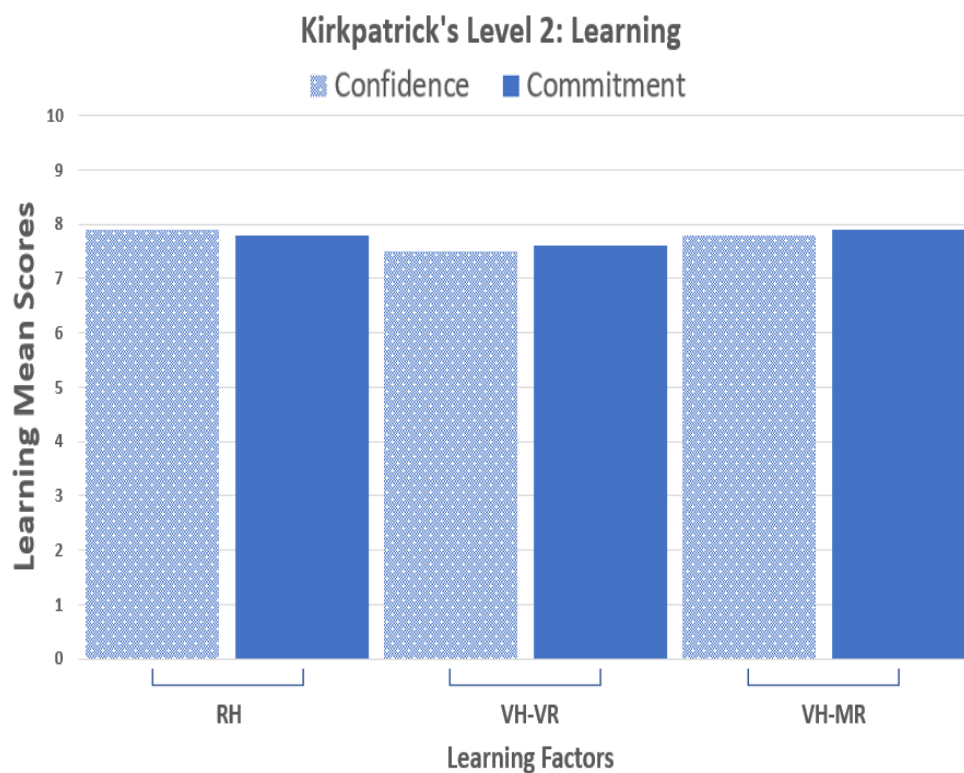


FIGURE 5.6: Learning mean scores for confidence and commitment per group

### 5.2.5 Quantitative Measures Summary

From the quantitative data, we found that within all three groups, there was an increase in the performance scores from the pre-test to the post-test levels, but the only



statistically significant increase was represented by the VH-MR group. Higher total scores were obtained by the groups VH-MR, VH-VR, and RH in that order, as shown in Table 5.1. However, the difference in performance scores among groups was not statistically significant. For the stress-level indicators, the results showed no statistically significant differences in HRV. However, the sub-scales of the DSSQ (engagement and distress) showed a statistically significant difference between and within groups. The social presence scale reported positive scores in both groups in interaction with VHs. The results indicated that participants in the VH-VR group had a greater sense of social presence, but the difference between groups was not statistically significant. Kirkpatrick's evaluations did not report statistically significant differences.

### 5.3 Qualitative Measures

The following sections describe qualitative text-based and multimedia-based information recorded from the participants to provide an extensive analysis of their responses during the experiment.

#### 5.3.1 Kirkpatrick's Level 2: Learning

Participants were asked to give their reason if they **rated themselves a seven or below in the confident and commitment scales**. We identified ten participants in the confident item, and eight participants in the commitment item. We asked them why they believed their confidence or commitment was not high. Here are some of the responses received from the participants.

1. "I am not required to do so."
2. "I do not have the necessary skills."
3. "I have other, higher priorities, I am not required to do so."
4. "I am not sure what is expected of me."
5. "Situational leadership works well in theory but in practice, people just don't perfectly fit into the four squares as mentioned. Humans are complicated and

leadership should be able to handle them well at that moment. That is not possible by just following which box do they sit in sort.”

6. “I do not have the necessary skills, No one will care if I actually do or don’t.”
7. “The lessons do not take into account the varying personality traits of individuals despite their confidences and competencies.”
8. “There is no incentive for me to do so.”

### 5.3.2 Feedback

Participants were also asked to provide their feedback about the experiment. Here are some of the comments.

1. “The situational leadership scenario was a good learning opportunity but there was one thing that I would like to share and that is practice. A newly emerging leader rarely have expertise to deal with the situational analysis. I believe that practice makes a man perfect. At the same time, the situational leadership II model is also of great help to learn and incorporate to achieve results. Therefore, if both knowledge (Situational Leadership II model) and experience (or continuous practice) combine together then the results would be more desirable.”
2. “Very interesting and informative.”
3. “I would be much more glad to answer computerized system than real human as your behavior changes drastically with the presence of the person in front of you.”
4. “I think this is a great opportunity to be exposed to various different real-life situations. I will definitely use what I have learned today in my daily work.”
5. “As first time user of virtual reality head-set, it felt strange but once the scenarios started I focused on what I had to do and did not notice the head-set or heart monitor.”
6. “Once the training was completed I was more confident.”
7. “I really like it. I think this method of training can help people to stay focused on what they are learning.”

8. “It was very interesting and great to hear new knowledge about leadership skills. The graphics were great for the virtual human. The voices were very good - made it more realistic. I really enjoyed it. For me to learn I need to practice a few times and read/listen a few times so I can remember more easily.”
9. “The situations were predictive. This made it easy to choose the response. I’m not sure if that is the intention, but I highly doubt real life is this predictive. Nevertheless, there’s clearly immense potential on this front!”

### 5.3.3 Multimedia Content

From the post-analysis of verbal and non-verbal responses, we can report a higher number of postural changes (e.g., leg shaking, touching hair, and interpersonal distance) assumed by participants in the RH condition, in comparison with the other two conditions. The role-players performing as followers in the RH condition were not under evaluation. However, we consider pertinent to report a full range of gestures, facial expressions, and postures (smiles, eye-gaze, arms-crossed, and interpersonal distance) that we were not able to replicate with the VHS in the other two groups. Finally, we want to report an interesting behavior of one of the participants in the VH-VR group who took the time to analyze aloud some of the VHS’ narratives and possible answers. Here are some of the comments.

1. “Well, that’s different, he’s changed the story because he originally said he didn’t want to do it, but he is now saying he wants me to show him.”
2. “Why did we hire this guy?.”
3. “I think this is a training solution.”

### 5.3.4 Qualitative Measures Summary

From the qualitative data analysis, we found that most of the participants who rate themselves a seven or below in the confident and commitment scales (Kirkpatrick’s level 2) were not required to use what was learned on a daily basis. A minority considered that the training experience did not take into account the complexity of human beings and their varying personality traits despite confidence and competency levels.

The participants also gave their feedback about the experiment. In general, many participants gave positive feedback about the training experience. From the comments, we can highlight that participants considered it was an excellent opportunity to be exposed to different real-life situations, where people can stay focused on what they are learning while putting into practice their skills. Participants also suggested improvements for the experiment, including:

- To use a wider range of virtual characters representing different cultures.
- To organize the scenarios based on the level of complexity, moving from the simple cases to the more complex interactions.
- To change the virtual space or room as the role of the participant's changes.

## Chapter 6

# Discussion

This chapter discusses the results found in the user study. It also explores possible explanations of the results and their relationship with previous research work. It also explains the limitations of the study.

### 6.1 Study Results

#### 6.1.1 Learning Performance

The analysis of the performance' scores obtained throughout the scenarios is done within and between groups. The results supported the hypotheses, H1 (There is no significant difference in learning performance scores among the three conditions), and partly, H2 (Learning performance scores will be significantly higher in the post-test level, in comparison to the pre-test level for all three conditions).

The within-group analysis showed an increase in scores from the pre-test to the post-test levels in all three groups. The increase in scores indicates the positive impact that both the first practice (or pre-test) and the information based-session, had on the higher number of correct responses (matches) made by participants during the post-test. The only statistically significant increase in scores was reported by the VH-MR group. The descriptive statistics showed that the higher scores were obtained by the VH-MR, VH-VR, and RH group in that order, however, the between-group analysis showed no significant difference in scores.

### 6.1.2 Stress Levels

The analysis of the stress levels is done within and between groups by evaluating the HRV indicators, and the DSSQ subscales. The overall stress-level results indicated that hypotheses H3 (There is a significant difference in stress levels among the RH condition, and the other two conditions with VHs) was not supported.

For the HRV, the within-group analysis showed an increase in HRV from the pre-test levels to the post-test in all three groups. As reported by Thayer et al. [69], a higher HRV represents a greater ability to successfully regulate our emotions to overcome a stressful situation. Our participants showed that the stress levels were higher during the pre-test and lowered during the post-test. The descriptive statistics showed that the VH-MR group obtained a higher HRV, and the RH group obtained a lower HRV. Nevertheless, the within-group analysis showed no significant difference in HRV from the pre-test to the post-test levels. Similarly, The between-group analysis showed no significant difference in HRV.

The results of the DSSQ are divided into three components: *Engagement*, *Distress*, and *Worry*. The engagement results showed an interaction effect between the RH and VH-MR groups and the pre-post levels as shown in Fig 5.3. The interaction effect indicated a significant increase in engagement experienced by participants in the VH-MR group during the post-test. The descriptive statistics showed an increase in engagement scores from the pre-test to the post-test in all three groups. A study by Matthews et al. [70] found that monotonous tasks tend to decrease task engagement. Thus, the increase in engagement scores indicates that participants perceived the experience as a dynamic, challenging game-like task. Higher scores in engagement were obtained by the VH-MR, RH, and VH-VR group in that order. For distress, a statistically significant decrease in scores from the pre-test to the post-test levels was found. According to Matthews et al. [71], an increase in distress levels is associated with an overload of the processing capacities. However, some tasks have been shown to reduce distress levels when participants enjoy the task [70]. The descriptive statistics showed that the lower scores in distress were obtained by the VH-MR group, followed by the RH and VH-VR groups. Finally, the results showed a decrease in worry from the pre-test to the post-test in the RH and VH-VR groups, indicating a reduction of self-focused attention. In general, performance tends to reduce worry, as the attention of the user is refocused on

external tasks [70]. However, the VH-MR group reported an increase in worry scores. Neubauer et al. [72] stated that worry tends to be maintained when the task provides opportunities for self-reflection and mind-wandering. Thus, we conjectured the higher scores in worry obtained by VH-MR are for the same reason.

### 6.1.3 Social Presence

From the results obtained by the social presence scale, fourteen out of twenty scores were positive, indicating that more than half of participants perceived the VHS to be realistic and assigned some degree of consciousness to them. These results are in line with other investigations where VHS were shown to evoke feelings of presence [73, 74]. The descriptive statistics show that participants in the VH-VR group reported a greater sense of social presence in comparison with participants in the VH-MR group. This could be because of the technical differences between the devices used to render the virtual and mixed reality experience. VHS in the MR experience were rendered with a lower resolution and reduced field of view due to the limited video feed through the stereo camera. Therefore, the behavioral realism of the VHS could have been best perceived in the VR group. This last analysis is congruent to what is reported by Rosenthal-von der Pütten et al. [74], “the more rich and realistic the behavior is and the more information can be obtained about the (virtual) other, the more presence is experienced.” However, the overall social presence results showed no significant difference between the VH-VR and VH-MR groups.

### 6.1.4 Overall Training Experience

The results of the Kirkpatrick’s questionnaires are divided into two main components. The first component is reaction (level one), and the second component is learning (level two). For reaction, we evaluated six items (program objectives, content relevance, facilitator knowledge, delivery, evaluation, and facility). For learning, we evaluated two items (confidence and commitment).

The component *reaction* represents the degree to which participants find the training favorable, engaging, and relevant for their tasks or jobs [65]. The results for reaction

showed that all the items were scored above average in all three groups indicating a positive reaction from the participants to the training experience and a consistent training structure. The descriptive statistics showed that the RH group had higher scores for program objectives, content relevance, facilitator knowledge, and delivery. VH-VR had higher scores for evaluation, and VH-MR had higher scores for facility. For Kirkpatrick's level two, *learning*, this represents the degree to which participants acquire the intended knowledge, skills, attitude, confidence and commitment based on their participation in the training [65]. We only evaluated confidence and commitment, as we already had a learning scale used to measure knowledge. The results for learning showed that both confidence and commitment scored above average in all three groups indicating a high degree of confidence and commitment from the participants to apply the knowledge acquired. The overall results showed no significant differences between groups for reaction and learning.

### 6.1.5 Overall Discussion

From the experiment results, we can now begin to answer our research questions. *Is the use of virtual human role-players an effective training tool for practicing and developing leadership skills?* The results indicated that the performance scores were not only similar but higher in interaction with VH role-players in both environments VR and MR, in comparison to the interaction with RH role-players. The stress-level indicators represented similar tendencies in all three groups. However, the analysis of both the HRV and DSSQ scales clearly indicated that VH role-players were shown to make participants feel comfortable and engaged while practicing leadership skills. The positive scores in the social presence scale represent the last indicator to fully answer our first research question. With support from the findings in our study, we can conclude that **virtual humans can be effective training tools to support the practice and development of leadership skills.**

Similarly, for the second research question, *Which computer-generated environment (VR or MR) has a greater impact on learning performance, stress levels, and social presence indicators?* Both computer-generated environments had a positive impact on all three measures. However, the results showed that MR had a greater overall impact on the performance scores and stress-level indicators. VR had a greater impact on the social



presence scale, but the resolution and limited field of view of the MR experience may have impacted the perception of behavioral realism as identified in the earlier section 6.1.3. This should be further investigated in the future study.

## 6.2 Limitations

We have identified some limitations during the development of the experimental platform. There were also some limitations identified by participants after the study. These limitations could be helpful for future researchers.

- Having a fixed set of answers and responses (structured role-plays) was useful for delivering a consistent training experience for all three groups. However, we think this type of interaction can limit in some way the total experience by narrowing down the number of possible alternatives. Increasing the number of choices rapidly becomes a difficult task for narrative designers, and complex narratives may result in unrealistic stories. Not following a proper structure also becomes a problem as users easily lose track of the instruction. Perhaps a smarter system should provide a semi-structured design, where the interaction follows a validated framework, and the users can formulate their answers.
- The development of the branching narratives was a time-consuming task, and it required the involvement of a subject matter expert.
- The stereo camera that we used in the study still has a low field of view, and it was set up using a lower resolution to compensate for low frame rate at higher resolutions (preventing symptoms of cybersickness). These technical limitations may have impacted the sense of social presence. As technology develops, and the field of view and frame rates improve in depth-sensing cameras, we expect future researchers re-validate this investigation.

## Chapter 7

# Future Work and Conclusion

This chapter identifies possible future areas of research, and briefly summarises the thesis, and the conclusions drawn from the results.

### 7.1 Future Work

We have already identified opportunities for further research in the limitation section of Chapter 6. Some other areas for future investigation include:

- One of the main motivations of our study was to evaluate the effectiveness of VH role-players, in order to complement and support traditional training delivery methods with the practice and development of leadership skills. However, after reviewing the outcomes obtained with VHs within VR and MR environments, a future study could investigate the effects that different computer-generated environments have when not only VHs but also RHs can coexist within these environments.
- A RH trainer delivered the training-based session we used for our experiment. Further research could also investigate the impact of having a VH trainer or vice versa, a captured RH superposed into the virtual environment.
- VH role-player selection is also something that would be interesting to investigate, considering a rich cultural diversity and its impact on learning performance.

## 7.2 Conclusion

In this thesis, we studied the effectiveness of VH role-players as training tools to support the practice and development of leadership skills. VHS were deployed within two computer-generated environments (VR and MR) and compared to RH role-players. Finally, we analyzed and evaluated the overall training experience for their effectiveness.

The prototype developed in the project provided an interactive experience with either real or virtual humans during eight structured role-plays driven by branching narratives developed with SLII content. We used an HMD to provide the VR interaction, and both an HMD and a depth-sensing camera to provide the MR interaction.

The prototype was used for a user experiment where we investigated three groups in interaction with either real or virtual humans during different times. The groups were organized based on the interaction type, one group interacted with RHs, and the other two interacted with VHS in different computer-generated environments (VR, and MR). The different times were represented by a pre-test and post-test, which were two practice-based instances where participants interacted with either RH or VH humans. In between tests, participants received an instruction-based session with the fundamental concepts of the SLII<sup>®</sup> model. The effectiveness of VHS was evaluated by analysis of learning performance, stress levels, social presence, and overall training experience. There were 30 participants in the user study. The study results showed that VHS can be effective training tools to support the practice and development of leadership skills. Both computer-generated environments had positive impacts on the results, but the MR environment had a greater influence on performance. The overall training demonstrated to be a positive and consistent experience.

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## Appendix A

# Appendix A: Information Sheet, Consent Form, and Advertisements



HUMAN ETHICS COMMITTEE

Secretary, Rebecca Robinson  
Telephone: +64 03 369 4588, Extn 94588  
Email: [human-ethics@canterbury.ac.nz](mailto:human-ethics@canterbury.ac.nz)

Ref: HEC 2019/87/LR Amendment 1

9 December 2019

Gonzalo Suarez  
HIT Lab NZ  
UNIVERSITY OF CANTERBURY

Dear Gonzalo

Thank you for your request for an amendment to your research proposal “Evaluating Virtual Humans as Role-Players to Practice and Develop Leadership Skills” as outlined in your email dated 2<sup>nd</sup> December 2019.

I am pleased to advise that this request has been considered and approved by the Human Ethics Committee.

Yours sincerely

A handwritten signature in black ink, appearing to be 'DS' followed by a stylized flourish.

Dr Dean Sutherland  
*Chair, Human Ethics Committee*

## Ngāi Tahu Consultation and Engagement Group



21 November 2019

Tēnā koe Gonzalo Suarez

RE: Evaluating Virtual Humans as Role-Players to practice & Develop Leadership

This letter is on behalf of the Ngāi Tahu Consultation and Engagement Group (NTCEG). The NTCEG considered your proposal and acknowledge it is a worthwhile and interesting project and you are clear about how you ought to take participants' (cultural) needs into account if and when applicable.

Given the scope of your project, no issues have been identified and further consultation with Māori is not required.

Thank you for engaging with the Māori consultation process. This will strengthen your research proposal, support the University's Strategy for Māori Development, and increase the likelihood of success with external engagement. It will also increase the likelihood that the outcomes of your research will be of benefit to Māori communities. We wish you all the best with your current project and look forward to hearing about future research plans.

The Ngāi Tahu Consultation and Engagement Group would appreciate a summary of your findings on completion of the current project. Please feel free to contact me if you have any questions.

Ngā mihi  
Maxine Bryant (on behalf of the NTCEG)

A handwritten signature in cursive script that reads 'Maxine Bryant'.

Director Research Services | Kaihautū  
Research & Innovation | Te Rōpū Rangahau  
University of Canterbury | Te Whare Wānanga o Waitaha  
Phone +64 3 369 5791, Private Bag 4800, Christchurch | Ōtautahi  
[ethicsmaoriconsultation@canterbury.ac.nz](mailto:ethicsmaoriconsultation@canterbury.ac.nz)  
<http://www.canterbury.ac.nz/research>



Department: HIT Lab NZ  
Telephone: +64 021 267 9635  
Email: [gonzalo.suarezvenegas@pg.canterbury.ac.nz](mailto:gonzalo.suarezvenegas@pg.canterbury.ac.nz)  
Date: 09/01/2020  
HEC Ref: 2019/87/LR

### Information Sheet for Participant

We are a research group at the Human Interface Technology Lab, NZ. We are conducting a research study on; Evaluating Virtual Humans as Role-Players to Practice and Develop Leadership Skills.

This study seeks to evaluate the effectiveness of virtual humans (VHs) as training tools intended to practice and develop leadership skills. VHs will be compared to real humans (RHs) during semi-structured role-plays. Content of The Situational Leadership II (SLII) model from Blanchard® is used as a framework to structure the role-plays. If you choose to take part in this study, your involvement in this project will be approximately 50 minutes. This experiment has three conditions, and you will be randomly assigned to **ONE** condition only. Next, we present a break-down of all three conditions, each of them organized in three consecutive stages:

- 1.- Role-play with RHs / SLII Session / Role-play with RHs (Face to face experience)
- 2.- Role-play with VHs / SLII Session / Role-play with VHs (Virtual reality experience).
- 3.- Role-play with VHs / SLII Session / Role-play with VHs (Mixed reality experience)

Please note that under the first condition, RHs are represented by live humans (students or actors) instructed to perform a specific role. In the second condition, VHs are rendered using a virtual reality head-mounted display (HMD). Finally, in the third condition, VHs are rendered using a mixed reality HMD. The inducement process is described next:

#### Pre-questionnaires (Approximately 5 min):

Before the experiment, you will be asked to fill out an informed consent form, and you will receive detailed instructions on how to perform the experimental task. Then, you will be asked to fill out a demographic questionnaire and a pre-task Stress Questionnaire. After complete the questionnaires, you'll be asked to wear a chest strap for capturing and recording your heart-rate. The analysis of your heart-rate will help determine the levels of stress experimented throughout the role-plays. Next, a video camera will be set up to record the interaction. The recording will be used only for the post-analysis of behavior and verbal response. Please note that your face will not be recorded, and therefore, your identity will not be revealed. Once the camera is set up, the experiment will begin based on the conditions proposed above (1, 2, or 3). Please note that you will be asked to wear a virtual/mixed reality head-mounted display if you are assigned to the conditions 2 or 3. The consecutive stages are described next:

#### 1<sup>st</sup> Stage (Approximately 10 min)

Sitting on a chair, you will get prepared to interact during semi-structured role-plays with either RHs or VHs. Your task will be to provide a guide to someone who reports directly to you (follower). Therefore, you will have to assume the position of a leader (e.g., Manager, Supervisor, Director, etc.). Role-plays will be driven by a turn-based branching narrative; once the follower is introduced, he or she will request your guidance,

then, you will choose to say in response one of the four pre-scripted answers displayed in front of you.

2<sup>nd</sup> Stage (Approximately 20 min)

This stage is merely informative (knowledge-based training); therefore, only your attention is required. During this stage, you will have to watch a video where a certified trainer in Situational Leadership II (SLII) explains the fundamental aspects of the SLII model.

3<sup>rd</sup> Stage (Approximately 10 min)

All the conditions from the first stage are repeated, but the followers will be presented in different SLII scenarios or situations. Once the follower is introduced, and your guidance has been requested, you will choose to say in response one of the four pre-scripted answers displayed. The experiment finalizes after this stage.

Post-questionnaires (Approximately 5 min):

At the end of the experiment, you will be asked to fill out a post-task stress questionnaire, a social presence questionnaire, and Kirkpatrick's level one and level two questionnaires.

In the performance of the tasks and application of the procedures, there is a risk of dizziness (also known as cyber-sickness) due to the use of the head-mounted display. Generally, the symptoms could last a few seconds to up to several minutes. If that occurs, you are allowed to stop the experiment at any time or extend the period between sessions to as long as you need it. We will also offer you a space to relax until the symptoms have faded.

Participation is voluntary and you have the right to withdraw at any stage without penalty. You may ask for your raw data to be returned to you or destroyed at any point. If you withdraw, we will remove the information relating to you. However, once the analysis of raw data starts on February 1<sup>st</sup> 2020, it will become increasingly difficult to remove the influence of your data on the results.

The Ken Blanchard Companies Inc® via Blanchard New Zealand have collaborated during this investigation authorizing the use of content of the Situational Leadership II (SLII) model. SLII is used as a framework to structure the role-play scenarios and to help determine the learning objectives of this investigation. Please note that the results of the project can be shared and published, but you may be assured of the complete confidentiality of data gathered in this investigation: your identity will not be made public. To ensure anonymity and confidentiality, all the collected data will remain within the HIT Lab NZ, and no one except the researchers involved in this project (main investigator Gonzalo Suarez, Co-Supervisor Sungchul Jung, and Senior Supervisor Rob Lindeman) will have access to the data. The data will be kept securely stored for a minimum period of 5 years on storage systems within the University of Canterbury, and securely destroyed after that. A thesis is a public document and will be available through the UC Library.

Please indicate to the researcher on the consent form if you would like to receive a copy of the summary of the results of the project.

The project is being carried out as a requirement for Masters in Human Interface Technology by Gonzalo Suarez under the supervision of Dr. Sungchul Jung who can be contacted at [sungchul.jung@canterbury.ac.nz](mailto:sungchul.jung@canterbury.ac.nz). He will be pleased to discuss any concerns you may have about participation in the project.

This project has been reviewed and approved by the University of Canterbury Human Ethics Committee, and participants should address any complaints to The Chair, Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch ([human-ethics@canterbury.ac.nz](mailto:human-ethics@canterbury.ac.nz)).

If you agree to participate in the study, you are asked to complete the consent form and return it before commencing the experiment.



Department: HIT Lab NZ  
Telephone: +64 021 267 9635  
Email: [gonzalo.suarezvenegas@pg.canterbury.ac.nz](mailto:gonzalo.suarezvenegas@pg.canterbury.ac.nz)



## Evaluating Virtual Humans as Role-Players to Practice and Develop Leadership Skills.

### Consent Form for participant

- ☐ I have been given a full explanation of this project and have had the opportunity to ask questions.
- ☐ I understand what is required of me if I agree to take part in the research.
- ☐ I understand that participation is voluntary, and I may withdraw at any time without penalty. Withdrawal of participation will also include the withdrawal of any information I have provided should this remain practically achievable.
- ☐ I understand that any information or opinions I provide will be kept confidential to the researcher and his supervisors and that any published or reported results will not identify the participants.
- ☐ I understand that all data collected for the study will be kept in locked and secure facilities and/or in password-protected electronic form and will be destroyed after five years.
- ☐ I understand that this project is done in collaboration with The Ken Blanchard Companies Inc® via Blanchard New Zealand, and the results can be shared with Blanchard®. However, I have been assured the complete confidentiality of data gathered in this investigation and that my identity will not be made public.
- ☐ I understand that parts of the anonymized data could be shared with other researchers if there is a need to do so (e.g., related development, teaching, or research).
- ☐ I understand that the interactions will be video recorded. However, my face will not be captured, and the recordings will only be used for post-analysis of the behavior and verbal response.
- ☐ I understand that a chest strap monitor will be used to track and record my heart-rate.
- ☐ I understand the risks associated with taking part and how they will be managed.
- ☐ I understand that I can contact the researcher Gonzalo Suarez at [gonzalo.suarezvenegas@pg.canterbury.ac.nz](mailto:gonzalo.suarezvenegas@pg.canterbury.ac.nz) or Supervisor Sungchul Jung at [sungchul.jung@canterbury.ac.nz](mailto:sungchul.jung@canterbury.ac.nz) for further information. If I have any complaints, I can contact the Chair of the University of Canterbury Human Ethics Committee, Private Bag 4800, Christchurch ([human-ethics@canterbury.ac.nz](mailto:human-ethics@canterbury.ac.nz))
- ☐ I would like a summary of the results of the project
- ☐ By signing below, I agree to participate in this research project.

Name: \_\_\_\_\_ Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Email address (for reports of findings, if applicable): \_\_\_\_\_

Once you have completed this form, please return it to the researcher before the commencement of the experiment.



## Participants Needed for a User Study with Virtual Humans

We are looking for volunteers to participate in a study that involves interaction with either virtual humans or real humans. The goal of this study is to evaluate the effectiveness of virtual humans as training tools intended to practice and develop leadership skills.

You would be asked to:

- Wear a chest strap that will track your heart-rate
- (there is no risk associated with this; it will not interfere with any bodily functions)
- Interact with either virtual humans or real humans
- Some interactions will require you to wear a VR headset
- Answer anonymous relevant questionnaires.

The expected duration of the study is approximately 50 minutes.  
A \$15 voucher will be given at the end of the study.

For more details, or to participate in the study, please contact:  
Gonzalo Suarez at [gonzalo.suarezvenegas@pg.canterbury.ac.nz](mailto:gonzalo.suarezvenegas@pg.canterbury.ac.nz)





## **Participants Needed for a User Study on: “Evaluating Virtual Humans as Role-Players to Practice and Develop Leadership Skills”.**



We are looking for volunteers interested in performing as role-players. The goal of this study is to evaluate the effectiveness of virtual humans as training tools intended to practice and develop leadership skills.

You will be asked to interact with participants following a script displayed on flashcards or monitors. Each participant will play the role of your Leader. Thus, you will have to play the role of the follower or the person who reports directly to the Leader.

Your participation will be relevant to make this experiment possible. However, your performance is not the main focus of this study, and therefore, you won't be under evaluation. Dates and times can be arranged as we approach the experiment date during January 2020.

You will be given a Westfield voucher worth \$10 for your time and effort.

For more details, or to participate in the study, please contact:

**Gonzalo Suarez**

[gonzalo.suarezvenegas@pg.canterbury.ac.nz](mailto:gonzalo.suarezvenegas@pg.canterbury.ac.nz)

## Appendix B

### Appendix B: Questionnaires



## Demographic Survey

Please fill out all the fields required:

Age:

Gender:

Male

Female

Other

Don't want to specify

Have you been assigned to a leadership position?

\* Leadership position = a person who leads, guide or commands someone.

Not at all

Few times a year

Few times a week

Daily

Do you have normal or corrected-to-normal vision?

Yes

No

Do you wear glasses or contact lenses?

Yes

No



## DSSQ-3 State Questionnaire

**Instructions:** This questionnaire is concerned with your feelings and thoughts at the moment. Please answer every question, even if you find it difficult. Answer, as honestly as you can, what is true of you. Please do not choose a reply just because it seems like the 'right thing to say'. Your answers will be kept entirely confidential. Also, be sure to answer according to how you feel **AT THE MOMENT**. Don't just put down how you usually feel. You should try and work quite quickly: there is no need to think very hard about the answers. The first answer you think of is usually the best.

For each statement, select an answer from 0 to 4, so as to indicate how accurately it describes your feelings **AT THE MOMENT**.

Definitely false = 0, Somewhat false = 1, Neither true nor false = 2, Somewhat true = 3, Definitely true = 4

	Definitely false	Somewhat false	Neither true nor false	Somewhat true	Definitely true
I feel concerned about the impression I am making.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel relaxed.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The content of the task will be dull.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am thinking about how other people might judge my performance.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am determined to succeed on the task.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel tense.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am worried about what other people think of me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am thinking about how I would feel if I were told how I performed.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Definitely false	Somewhat false	Neither true nor false	Somewhat true	Definitely true
Generally, I feel in control of things.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am reflecting about myself.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My attention will be directed towards the task.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am thinking deeply about myself.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel energetic.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am thinking about things that happened to me in the past.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am thinking about how other people might perform on this task.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am thinking about something that happened earlier today.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Definitely false	Somewhat false	Neither true nor false	Somewhat true	Definitely true
I expect that the task will be too difficult for me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I will find it hard to keep my concentration on the task.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am thinking about personal concerns and interests.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel confident about my performance.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am examining my motives.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can handle any difficulties I may encounter.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am thinking about how I have dealt with similar tasks in the past.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am reflecting on my reasons for doing the task.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Definitely false	Somewhat false	Neither true nor false	Somewhat true	Definitely true
I am motivated to try hard at the task.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am thinking about things important to me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel uneasy.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel tired.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel that I cannot deal with the situation effectively.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel bored.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>





### DSSQ-3 State Questionnaire

**Instructions:** This questionnaire is concerned with your feelings and thoughts while you were performing the task. Please answer every question, even if you find it difficult. Answer, as honestly as you can, what is true of you. Please do not choose a reply just because it seems like the 'right thing to say'. Your answers will be kept entirely confidential. Also, be sure to answer according to how you felt **WHILE PERFORMING THE TASK**. Don't just put down how you usually feel. You should try and work quite quickly: there is no need to think very hard about the answers. The first answer you think of is usually the best.

For each statement, select an answer from 0 to 4, so as to indicate how accurately it describes your feelings **WHILE PERFORMING THE TASK**.

Definitely false = 0, Somewhat false = 1, Neither true nor false = 2, Somewhat true = 3, Definitely true = 4

	Definitely false	Somewhat false	Neither true nor false	Somewhat true	Definitely true
I felt concerned about the impression I am making.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt relaxed.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The content of the task was dull.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I thought about how other people might judge my performance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I was determined to succeed on the task.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt tense.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I was worried about what other people think of me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I thought about how I would feel if I were told how I performed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Definitely false	Somewhat false	Neither true nor false	Somewhat true	Definitely true
Generally, I felt in control of things.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I reflected about myself.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My attention was directed towards the task.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I thought deeply about myself.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt energetic.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I thought about things that happened to me in the past	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I thought about how other people might perform on this task	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I thought about something that happened earlier today.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Definitely false	Somewhat false	Neither true nor false	Somewhat true	Definitely true
I found the task was too difficult for me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I found it hard to keep my concentration on the task.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I thought about personal concerns and interests.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt confident about my performance.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I examined my motives.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt like I could handle any difficulties I encountered	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I thought about how I have dealt with similar tasks in the past	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I reflected on my reasons for doing the task	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	Definitely false	Somewhat false	Neither true nor false	Somewhat true	Definitely true
I was motivated to try hard at the task.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I thought about things important to me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt uneasy.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt tired.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt that I could not deal with the situation effectively.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt bored.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



## Social Presence Scale Questionnaire

**Instructions:** Thinking about the training scenario you just completed, please indicate to what degree you agree with each statement:

[illegible]



## Kirkpatrick Level 1 Reaction Sheet Questionnaire

**Instructions:** Thinking about the training scenario you just completed, please indicate to what degree you agree with each statement:

	Strongly Disagree	Disagree	Agree	Strongly Agree
I understood the learning objectives that were outlined during the training scenario.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I was able to relate each of the learning objectives to the learning I achieved.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I will be able to immediately apply what I learned.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My learning was enhanced by the knowledge of the facilitator.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I was well engaged during the session.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I was comfortable with the duration of the session.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I was given ample opportunity to practice the skills I am asked to learn.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I found the room atmosphere to be comfortable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I experienced minimal distractions during the session.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



## Kirkpatrick Level 2 Learning Sheet Questionnaire

**Instructions:** Thinking about the training scenario you just completed, please indicate to what degree you agree with each statement:

	Not at all Confident	0	1	2	3	4	5	6	7	8	9	Totally Confident	10
To what degree are you confident that you will be able to apply what you learned in this training scenario?		<input type="radio"/>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		<input type="radio"/>

*\*If you rated yourself a 7 or below, please answer the following question. Check all that apply.*

My **confidence** is not high because:

☐ I do not have the necessary skills

☐ I am not sure what is expected of me

☐ I have other, higher priorities

☐ I am not required to do so

☐ No one will care if I actually do or don't

☐ There is no incentive for me to do so

☐ Other (please explain):

**Instructions:** Thinking about the training scenario you just completed, please indicate to what degree you agree with each statement:

	Not at all Committed 0	1	2	3	4	5	6	7	8	9	Totally Committed 10
To what degree are you committed to try to apply what you have learned?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

*\*If you rated yourself a 7 or below, please answer the following question. Check all that apply.*

My **commitment** is not high because:

☐ I do not have the necessary skills

☐ I am not sure what is expected of me

☐ I have other, higher priorities

☐ I am not required to do so

☐ No one will care if I actually do or don't

☐ There is no incentive for me to do so

☐ Other (please explain):

## Appendix C

# Appendix C: Blanchard® Agreement, and Role-Play Scenarios

## Letter of Agreement

Gonzalo Suarez  
31B Celia St, Redcliffs  
Christchurch, New Zealand

02/10/2019

The Ken Blanchard Companies Inc ®  
125 State Place  
Escondido, CA 92029

Blanchard International Group New Zealand Limited  
dba Blanchard New Zealand  
c/- service@blanchard.co.nz

To Whom It May Concern,

via Blanchard New Zealand, with

This letter serves as a formal agreement between The Ken Blanchard Companies Inc ® and Gonzalo Suarez, where I, Gonzalo Suarez, agree to the following terms expressed by The Ken Blanchard Companies Inc ®:

1. Submit to Blanchard® any and all of my study works containing any Blanchard® content and Intellectual Property
2. Share my project and study learnings with Blanchard®
3. Allow Blanchard® to freely on-share the learnings as in 2 above without fee in a meaningful way
4. Limit the use of Blanchard® content to my study programme only and not commercialise or monetarise Blanchard® content in any way
5. Be fully transparent with Blanchard® in all aspects involving any Blanchard® reference and content associated with my study project
6. Detail acknowledgement and ownership of all Blanchard® content that I include in my study project as: '© Copyright The Ken Blanchard Companies Inc. All rights reserved. Limited permission granted in 2019 by Blanchard NZ to Gonzalo Suarez for study use only.

Sincerely,

  
**Gonzalo Suarez**

Masters Student  
Human Interface Technology Lab NZ / Hangarau Tangata, Tangata Hangarau  
Level 2, John Britten Building,  
University of Canterbury  
Christchurch 8140  
E: [gonzalo.suarezvenegas@pg.canterbury.ac.nz](mailto:gonzalo.suarezvenegas@pg.canterbury.ac.nz)

  
**HITLabNZ**  
Human Interface Technology Lab New Zealand  
Hangarau Tangata, Tangata Hangarau  
[www.hitlabnz.org](http://www.hitlabnz.org)

### Limited Term Approval Note:

Conditional upon the passive or active agreement of The Ken Blanchard Companies Inc. i.e. 'Blanchard®', I, Malcolm K Sutherland, Principal, Blanchard New Zealand, hereby extend limited permission to Gonzalo Suarez to proceed in his academic, non-commercial 'Role-Play Dynamics with Virtual Humans / Experiment Design Proposal' technology study project to the above conditions. The expiry date of this Limited Term Approval will be 31 March 2020.

  
Principal  
Blanchard New Zealand  
[malcolm.sutherland@blanchard.co.nz](mailto:malcolm.sutherland@blanchard.co.nz)

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NEW ZEALAND

[www.blanchard.co.nz](http://www.blanchard.co.nz)

10 October 2019



Scenario 1 (D1)				
This scenario is a conversation between you (a Supervisor) and Alice, a Team Leader who reports directly to you. You have asked Alice to organize an end-of-year party for more than forty employees within the next two months.				
Basic Information about Alice				
Alice is excited about the task. However, she does not have previous experience organizing parties, and she seems unclear about what to do. Alice is open to any guidance you can give her.				
Alice Introduction				
Thank you for having this meeting with me. I am feeling really excited about this party. I love the idea of having a big celebration with all the employees. However, I don't have previous experience, and I would like to know where to start.				
Participant possible answers	S1(+2)	S2(+1)	S3(-1)	S4(-2)
	I appreciate your enthusiasm for organizing our end-of-year party.	What concerns do you have about organizing this party?	What do you want to focus on today?	Tell me what you are more excited about?
Alice response	Thank you, I am very excited about this task, and I want to start as soon as possible.	Well, my first concern is that I haven't prepared a party like this before.	Well, I would benefit from knowing exactly how to get started with the party arrangements.	I love parties, and I want to start as soon as possible with all the arrangements.
Participant possible answers	S1(+2)	S2(+1)	S3(-1)	S4(-2)
	Since you haven't done this before, I'll provide you with some direction.	Would it be helpful if I provide you with some direction? But I would also like to hear your ideas.	Would listening be more useful than advice or direction?	I know you are taking the lead, but I'm here when and if you need me.
Alice response	Great, that's precisely what I need to get started	That sounds good, but I don't have so many ideas to share.	I don't think so, what I need is more direction.	Thank you, but I don't feel the same, the truth is that I don't know where to start.
Participant possible answers	S1(+2)	S2(+1)	S3(-1)	S4(-2)
	You have to book a ceremony hall. Get in contact with Jason from HR; he will help you with the details.	What do you think about booking a ceremony hall where we can celebrate?	But look how much you have achieved already, what's getting in your way?	How can I support you?
Alice response	That's excellent; now I have something to work on.	I believe that might help.	I really don't know where to start.	I need some direction to get started.
Participant possible answers	S1(+2)	S2(+1)	S3(-1)	S4(-2)
	That's great, let's set up our next meeting on Thursday the 21st at 3:00 pm.	Great, I'll touch base with you on Thursday the 21st.	You will know, you always figure it out. Be sure to call me when you need me.	I trust your judgment, how do we stay in touch?
Alice response	Great, you have been very helpful. I'll see you then.	Thank you. I'll see you then.	Ok, I'll do that, thanks.	I don't know. Thank you for your time.
Feedback				
Alice seems excited about the task. Her commitment is high. However, she has no previous experience. Thus, her competence is low. Alice is definitely in need of a Directing style of leadership.				
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Scenario 2 (D2)	
This scenario is a conversation between you (a School Principal) and Tom, one of your teachers. You have asked Tom to use a new online tool introduced to your school to improve how student's grades are managed. This is your first meeting since then.	
Basic Information about Tom	
Tom is reluctant to learn the new online tool, preferring to use the old system instead. You have explained to Tom the benefits of using it. So far, your efforts have been ineffective. He continues to find excuses not to learn the new tool. You should:	

Tom Introduction				
Well, about this new online tool, I'm not sure if I have the time to learn how it works and still being able to do my job. I believe this new system is going to demand a lot of work.				
Participant possible answers	S1(+1)	S2(+2)	S3(-1)	S4(-2)
	I appreciate your initiative to learn this new online tool.	I understand you might feel overwhelmed by having to learn a new system.	I want you to start using this new online tool. I believe it won't be a big deal for you.	I know that you can handle it.
Tom response	Thank you, but I feel things are not going as I expected.	Yes, and I'm also feeling concerned about my lack of progress on this task.	Well, I don't feel the same; there is a lot on my plate right now.	I'm not sure about that. I'm struggling with this new task.
Participant possible answers	S1(+1)	S2(+2)	S3(-1)	S4(-2)
	I know exactly what needs to be done to get you on your feet.	Would it be helpful if I provide you with some direction? But I would also like to hear your ideas.	Would listening be more useful than advice or direction?	I know you are taking the lead, but I'm here when and if you need me.
Tom response	Just for my understanding, why this new system is so important for the school?	That would be great, I'd like to share my ideas, but I also need some direction from you.	I don't think so, can you help me understand why this is the best approach for the school?	I'm sorry, but that's not the truth. I'm concerned about my progress.
Participant possible answers	S1(+1)	S2(+2)	S3(-1)	S4(-2)
	This tool improves how information is managed. Let's start from the basics; this is how you enter and save student's grades.	This tool will increase productivity. Look how easy it is to generate reports. What do you think?	Since you've asked, this tool will increase productivity. What would it take for you to be re-excited about this task?	I'm confident you will be able to accomplish this task. Is there anything I can do to help?
Tom response	Thank you for that, do you have any other resources that would be helpful to me?	I believe that's useful. We used excel to run our reports, but what you have shown me facilitates the process. When would you like an update?	I need you to show me how to use this tool. I need some examples or resources to get started.	Who might be a good role model, coach, or teacher?
Participant possible answers	S1(+1)	S2(+2)	S3(-1)	S4(-2)
	Sure, I'll provide you with more examples in our next meeting on Friday the 21st at 1:00 pm.	I'll touch base with you Friday the 21st. Here are some resources and examples to help you get started.	You have the skills. Remember all the positive feedback you received last year? Just do the same.	You have the experience. I trust your judgment. When do we meet again?
Tom response	Thank you. I'll see you then.	Oh great! I'll see you then.	Ok, I'll do that, thanks.	I don't know. Thank you for your time.

Feedback	
Tom lacks skills and experience. His competence in using this tool is low. Due to fear, lack of interest, or for some other reason, he is not motivated to learn the new tool and does not see the benefits of it. Thus, his commitment to the task is low. Tom needs a Coaching style of leadership.	
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Scenario 3 (D3)				
This scenario is a conversation between you (a Supervisor) and Denise, a trainer officer who reports directly to you. Denise has demonstrated so much ability on an important training initiative that you have asked her to make a presentation to a group of Managers who will be visiting next week.				
Basic Information about Denise				
Denise has given several successful presentations about the training initiative to her colleagues. Unfortunately, she seems to lack confidence about this upcoming presentation. You should:				
Denise Introduction				
I want to talk to you about the upcoming presentation of our training initiative, which I understand, is very important for the company. The thing is, I know I have done this before, but for some reason, I've been feeling extremely nervous about it.				
Participant possible answers	S1(-1)	S2(+1)	S3(+2)	S4(-2)
	I appreciate your commitment to the training initiative.	I understand you might feel overwhelmed by the upcoming presentation.	I understand how you are feeling; How can I help?	I know that you can handle it. What feedback have you been getting from your colleagues?
Denise response	Thank you. I believe in this training initiative, but I'm still nervous about what I'm going to say.	Yes, and I'm also feeling concerned about the short amount of time we have to get prepared.	I've been thinking about the content of the presentation, and I would like to hear your feedback.	My colleagues gave me excellent feedback, but I'm still feeling very nervous about it.
Participant possible answers	S1(-1)	S2(+1)	S3(+2)	S4(-2)
	Would it be helpful if I provided you with some direction?	Would it be helpful if I provide you with some direction? But I would also like to hear your ideas.	That's ok, what alternatives have you considered?	I know you are taking the lead. Is there anything I can do to help?
Denise response	What I would like to hear is your feedback about the content I have prepared for the presentation.	That can help. What if we use the same content I used in my previous presentations. What do you think about that?	Well, my colleagues were happy with my previous presentations, so I was considering using the same content. What do you think?	I'm not sure if I'm going to get your support and time if problems come up.
Participant possible answers	S1(-1)	S2(+1)	S3(+2)	S4(-2)
	I know exactly what you need. I'll prepare a few slides with the content you have to use.	That's ok, however, here are some extra ideas that we may want to consider.	Yes, I believe that's great, just like last time. I'm confident you will do an excellent job	I know you can handle it.
Denise response	Thank you for that, but what about my ideas?	That's good, but why do you think those ideas are important?	That's what I needed. Thank you for listening.	I'm comfortable being in front of a group, but I'm still feeling nervous about it.
Participant possible answers	S1(-1)	S2(+1)	S3(+2)	S4(-2)
	Just practice with the content I'm going to send to you. We'll meet on Wednesday the 21st at 1:00 pm.	I'll touch base with you Friday the 21st. Here are some extra resources that I'll recommend you to use.	Remember that you have the skills. Do not forget about the positive feedback you have received.	You have the experience. We are happy with your contributions. When do we meet again?
Denise response	Ok, see you then.	Thanks. I'll see you then.	Excellent, I'll let you know when I'd like to meet again.	I'll let you know. Thank you for your time.
Feedback				
Denise has experience. Her competence is high. The problem is her fear that she cannot do a good job with the presentation. Thus, her high competence and shaky confidence suggest that she needs a Supporting style of leadership.				
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Scenario 4 (D4)				
This scenario is a conversation between you (a Research Supervisor) and Peter, one of your Master's students. Peter is excellent at completing assignments, always turning them in on time on Monday morning, before your weekly meeting.				
Basic Information about Peter				
Peter always takes great pride in how thorough and organized he is. However, It is now Monday afternoon, time for your meeting, and you have not received his weekly assignment. You should:				
Peter Introduction				
Hi there, it's very nice to see you again, we have a lot to catch up on. I would like to share with you what I've been working on.				
Participant possible answers	S1(-2)	S2(-1)	S3(+1)	S4(+2)
	What I would like to talk to you about is your weekly assignment.	How are you feeling?	So how are things going with your weekly assignment?	What would you like to talk about?
Peter response	Ok, let's talk about that. Up to now, I have been able to investigate more in-depth similar subjects related to the assignment.	I'm feeling excited about this opportunity. It has been busy lately, but I love the experience.	I apologize for being late on my delivery, but in the end, I decided to keep investigating more about related subjects.	I did finalize my assignment for this week, but then I decided to continue research on related subjects as it was fascinating.
Participant possible answers	S1(-2)	S2(-1)	S3(+1)	S4(+2)
	Remember that your priority is to submit on time your weekly assignments.	Would it be helpful if I provide you with some direction? But I would also like to hear your ideas.	That's ok, what other subjects have you considered?	I know you are taking the lead. Is there anything I can do to help?
Peter response	I'm sorry, I thought you would have appreciated the extra effort invested.	As I was working on the assignment, I had another idea, and I decided to investigate more about related subjects.	Well, I believe we can evaluate leadership theories using virtual humans. Both subjects are fascinating.	Well, I could do even more if I had the following resources with me, a virtual reality headset, and a powerful computer.
Participant possible answers	S1(-2)	S2(-1)	S3(+1)	S4(+2)
	That's ok, just make sure you don't delay your submissions.	That's ok, however, here are some extra subjects that we should focus on.	Yes, I believe both are interesting subjects. I'm confident you will do an excellent job.	Sure, I'll provide you with what you have requested. I trust your judgment.
Peter response	Thank you, but I considered this particular subject required more research.	I thought I had the autonomy to decide what subjects to investigate.	I believe so. I always wanted to have a challenge like this.	Thank you for trusting me. I will not disappoint you.
Participant possible answers	S1(-2)	S2(-1)	S3(+1)	S4(+2)
	I want you to submit the assignment today by 5:00 pm with what I requested. We'll meet again Monday the 23 <sup>rd</sup> at 1:00 pm.	You can investigate other subjects, but don't forget about the ones I have recommended.	Anything to help, I can see how excited you are about the subjects.	We have always benefited from your experience and commitment. When do we meet again?
Peter response	Ok, see you then.	Thank you. I'll see you next week.	Great, I'll see you next Monday 23 <sup>rd</sup> .	I'm glad to hear that. Thank you for your recognition. I'll see you next Monday 23 <sup>rd</sup> at 1:00 pm.
Feedback				
Peter is quite capable of and very committed to turning in his assignments on time. He will most likely resolve this single incident of lateness on his own. All the information suggests he is high in both competence and commitment. Peter needs a Delegating style of leadership.				
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Scenario 5 (D1)	
You supervise a company that operates with trucks. Jack, one of your employees, has not been maintaining his vehicle, and several breakdowns have occurred on his truck.	
Basic Information about Jack	
Jack has worked for the company for only two months and seems unclear about what to do. Jack wants to change the situation, but he does not have the skills. You should:	

Jack Introduction				
Thank you for meeting with me. I want to apologize for the several breakdowns on my truck. I'm willing to learn what is required to do this job. However, I don't have previous experience, and I would like to know where to start.				
Participant possible answers	S1(+2)	S2(+1)	S3(-1)	S4(-2)
	I appreciate your enthusiasm for wanting to learn.	What concerns do you have about truck maintenance?	What do you want to focus on today?	Tell me what you are more excited about?
Jack response	Thank you. I am very excited about this job, and I want to keep it.	Well, I don't know what parts of the truck need to be inspected for maintenance.	Well, I would benefit from knowing exactly how to conduct the maintenance on my truck.	I'm very excited about this job, and I want to keep it.
Participant possible answers	S1(+2)	S2(+1)	S3(-1)	S4(-2)
	Since you haven't done this before, I'll provide you with some direction.	Would it be helpful if I provide you with some direction? But I would also like to hear your ideas.	Would listening be more useful than advice or direction?	I know you are taking the lead, but I'm here when and if you need me.
Jack response	Great, that's precisely what I need, I want to learn as much as possible.	I appreciate that. But don't ask me about maintenance, I just know how to drive the truck.	I don't think so. I would not know what to ask. What I need from you is more direction.	Thank you, but I don't know where to start or what parts to inspect for maintenance.
Participant possible answers	S1(+2)	S2(+1)	S3(-1)	S4(-2)
	You have to inspect your wheels, brakes, and controls every week. I'll show you how to do it.	What do you think if we inspect the wheels, brakes, and controls every week?	You are a great driver, what's getting in your way?	How can I support you?
Jack response	That's cool, is there anything else that I need to know?	I believe that might help, but you will have to show me how.	I really don't know how to inspect my truck.	I need some direction to get started.
Participant possible answers	S1(+2)	S2(+1)	S3(-1)	S4(-2)
	Come to my office Tuesday the 12 <sup>th</sup> at 10:00 am. I want to show you how to inspect the engine.	That's ok. Here you have a manual with all the parts to inspect. I'll see you Thursday the 21st.	You will figure it out. Just call me if you need me.	I trust your judgment, how do we stay in touch?
Jack response	I really appreciate all your help, and I won't disappoint you. See you then.	Thank you. I'll see you then.	Ok, I'll do that, thanks.	I don't know. Thank you for your time.

Feedback	
Jack has only two months on the job, and he is unclear about what to do. Although his competence is quite low, he is committed to changing the situation. Therefore, Jack needs a Directing style of leadership.	
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Scenario 6 (D2)	
You manage a call center for a large company in telecommunications. Margaret, one of your representatives who answers the customer hotline, has been very rude to her customers and doesn't seem to care.	
Basic Information about Margaret	
In monitoring her calls, you have noticed Margaret seems to lack product knowledge, doesn't offer solutions, and frequently blames the customers. You have had several customer complaints over the last weeks. You should:	

Margaret Introduction				
Hi, I know that you wanted to see me, what are we having this meeting for?				
Participant possible answers	S1(+1)	S2(+2)	S3(-1)	S4(-2)
	We have had several customer complaints about you. I'll to set you a goal to improve your customer interactions.	We have had several customer complaints about you. I believe you lack product knowledge. What do you think?	We have had several customer complaints about you. What can you do to improve this situation?	We have had several customer complaints about you. It is very important to provide good customer service.
Margaret response	I'm sorry, there is a lot on my plate right now. What is the goal that you have mentioned?	Yes, I'm also feeling concerned about the knowledge I have about the products.	Well, I've been feeling a little discouraged. I probably need more training.	I understand, but I'm concerned about the knowledge I have about the products.
Participant possible answers	S1(+1)	S2(+2)	S3(-1)	S4(-2)
	I know exactly what needs to be done to get you on your feet.	That's ok. I'll provide you with some direction, but I would also like to hear your ideas.	What training do you believe is best for you right now?	You will have to improve your performance.
Margaret response	Perfect, I need some direction from you, but I'd also like to share my ideas.	That sounds great. I feel that's what I need.	I'm not sure about that. Any customer service and product training might help, I believe.	That's ok, but I also need some direction from you.
Participant possible answers	S1(+1)	S2(+2)	S3(-1)	S4(-2)
	I want you to complete this specific customer service and product training to improve your customer interactions.	I want you to complete this specific customer service and product training. What do you think about that?	I'm ok with that if you consider that's beneficial to improve your performance.	I know that you can handle it.
Margaret response	I'll be happy to complete those courses, but can we include a course on how to manage difficult customers?	That's excellent, but can we include an extra course on how to manage difficult customers?	I think it would be better if you recommend me some courses and then I give you my opinion.	I'm feeling stuck. What do you think I should do to improve my performance?
Participant possible answers	S1(+1)	S2(+2)	S3(-1)	S4(-2)
	Only complete the courses I have recommended. Let's meet Friday the 25 <sup>th</sup> at 1:00 pm to talk about your progress.	Sure we can. I'll touch base with you on Friday the 25 <sup>th</sup> . I'll provide you with feedback on your progress.	I'll leave up to you to decide what courses are best for you. I'm confident you will improve.	You have the experience. I trust your judgment. When do you want to meet again?
Margaret response	Thank you. I'll see you then.	Great. I'll see you then.	Ok, I'll do that, thanks.	I don't know. Thank you.

Feedback	
Margaret lacks the necessary product knowledge to answer customer's questions, which may account for her negative attitude. Her competence is low in terms of responding to customers and is probably discouraged. Margaret needs a Coaching style of leadership.	
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<b>Scenario 7 (D3)</b>	
You have been recently promoted to Marketing Manager. Anton, a User Experience Designer who has worked on your team for more than three years, has shown a great capacity for solving problems and pushing the team's thinking.	
<b>Basic Information about Anton</b>	
Anton's past performance has been better than average, and, in fact, he was even considered for your job before you were promoted. In the three months that you have been in charge, there has been a steady decline in his problem-solving ability. He is not contributing his expertise to the team. You should:	

<b>Anton Introduction</b>				
Hi, the guys told me that you wanted to see me in your office, how can I help?				
Participant possible answers	S1(-1)	S2(+1)	S3(+2)	S4(-2)
	I want to talk about your recent decline and unwillingness to contribute to the team.	I want to talk about your recent decline and unwillingness to contribute to the team. I believe something is going on. What is your perspective?	I want to talk about your recent decline and unwillingness to contribute to the team. What may be contributing to it?	How do you think you are doing on your projects lately?
Anton response	Ok, I understand, what do you want to tell me about that.	I understand, but for some reason, I'm not feeling motivated anymore.	Well, I'm not feeling excited about the projects anymore.	I'm not sure. I'm not feeling excited about the projects I have been assigned.
Participant possible answers	S1(-1)	S2(+1)	S3(+2)	S4(-2)
	I know exactly what needs to be done to get you on your feet.	I believe that you are getting bored of the same projects. What about if I assign you new projects?	What projects do you believe are best for you right now?	You will have to improve your performance.
Anton response	I would like you to hear how I'm feeling about my performance.	That could help. I would also like to have a small team to lead with people I know. What do you think about that?	Well, you know I love challenges. What do you think about assigning me the Coca-Cola project and a small team to lead with people I know?	I know, but that doesn't make any difference. Do you have any suggestions for increasing my motivation?
Participant possible answers	S1(-1)	S2(+1)	S3(+2)	S4(-2)
	I'm going to assign you the Coca-Cola project, and you will have to collaborate with Jack and Linda.	I'm going to assign you the Coca-Cola project. I recommend you meet Jack and Linda; they have experience. What do you think?	I believe the Coca-Cola project is perfect for someone with your experience, and leading a small team sounds like a good challenge for you.	I'll talk to some of your coworkers. I believe they can help boost your motivation.
Anton response	The Coca-Cola project sounds exciting, but what about leading a small team with people I know?	That sounds exciting, but what about leading a small team?	That's what I needed. Thank you for listening and for the opportunity.	I'm not sure if I'm going to be able to talk to them. I need someone I could trust and who can recognize my work.
Participant possible answers	S1(-1)	S2(+1)	S3(+2)	S4(-2)
	Jack and Linda are working on similar projects. Their experience will be beneficial. Let's meet Wednesday the 12 <sup>th</sup> at 1:00 pm to check on your progress.	Let's talk about that after you meet Jack and Linda. We need your expertise, and we'll work together to turn things around. I'll touch base with you Friday the 21 <sup>st</sup> .	We need your expertise and creativity. I'm confident you will do an excellent job.	You have the experience. We are happy with your contributions. When do we meet again?
Anton response	Ok, see you then.	Thanks. I'll see you then.	Excellent, I'll let you know when I'd like to meet again.	I'll let you know. Thank you for your time.

<b>Feedback</b>	
In the past few months, Anton's performance has begun to slack off. His commitment to high performance is the source of his difficulty. Anton needs a Supporting style of leadership to help him explore the reasons for his lack of commitment and get him back to being the peak performer he once was.	
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Scenario 8 (D4)				
You manage a sales company with 15 sales representatives. You have to do projections for next year's sales goals and need some help. You are about to meet with Stacey, your most experienced assistant to assign her the task of gathering the data for these projections over the next month.				
Basic Information about Stacey				
Stacey has had experience in all phases of the sales process and has a talent for data analysis. She wants the assignment. You should:				
Stacey Introduction				
Hi there, it is very nice to see you again. Is there anything I can do for you?				
Participant possible answers	S1(-2)	S2(-1)	S3(+1)	S4(+2)
	I want you to compile the sales projections.	I want you to compile the sales projections, and I would love to use some of your ideas.	I want you to compile the sales projections. Your skills will be beneficial for this task.	I want you to compile the sales projections by the end of the month.
Stacey response	I would love to do that. I have the experience, and It shouldn't take me too long to have something ready for you.	That's an exciting opportunity. My experience tells me we use the same format as we did in previous years.	That's great. I have the experience, and It shouldn't take me too long to have something ready for you.	That's excellent. I was hoping you trusted me with that task.
Participant possible answers	S1(-2)	S2(-1)	S3(+1)	S4(+2)
	This is the format I want you to use and the steps you have to follow. I also want you to meet with Jack from finance to brainstorm.	I want you to follow these steps, but you are right about the format. Let's use the same as in previous years.	Great, that's what I thought. How will you go about data collection and analysis?	You can always contact me if you have any questions.
Stacey response	I was considering using the same format we used the previous years, and I believe meeting with Jack is not necessary.	Thank you for considering my idea. However, I'm not sure about those steps you have recommended.	I was considering using the same format we used for previous years.	Thank you for giving me the autonomy that I need.
Participant possible answers	S1(-2)	S2(-1)	S3(+1)	S4(+2)
	That's not what I have requested from you. Please do what I said.	And what are the steps that you have in mind?	Yes, I believe we can use the same format. I'm confident you will do an excellent job.	Sure, I trust your judgment.
Stacey response	I'm sorry, I thought I had more autonomy.	I was considering setting up new goals before the analysis.	I believe so. I love to be challenged.	Thank you for trusting me. I will not disappoint you.
Participant possible answers	S1(-2)	S2(-1)	S3(+1)	S4(+2)
	I want you to keep me informed before you finalize the report. Let's meet Friday the 23 <sup>rd</sup> and Friday the 30 <sup>th</sup> at 1:00 pm.	That's a good initiative that we can include in future reports, but now, let's stick to the steps I've recommended.	Anything to help, I can see how excited you are about this assignment.	We have always benefited from your experience and commitment. When do we meet again?
Stacey response	Ok, see you then.	Thank you. I'll see you next week.	Great, I'll see you Friday the 23 <sup>rd</sup> .	I'm glad to hear that. Thank you for your recognition. I'll see you Friday the 23 <sup>rd</sup> at 1:00 pm.
Feedback				
Stacey has the desire and the skill to do these projections. Thus, her commitment is high, and her competence is high. Stacey needs a Delegating style of leadership.				
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